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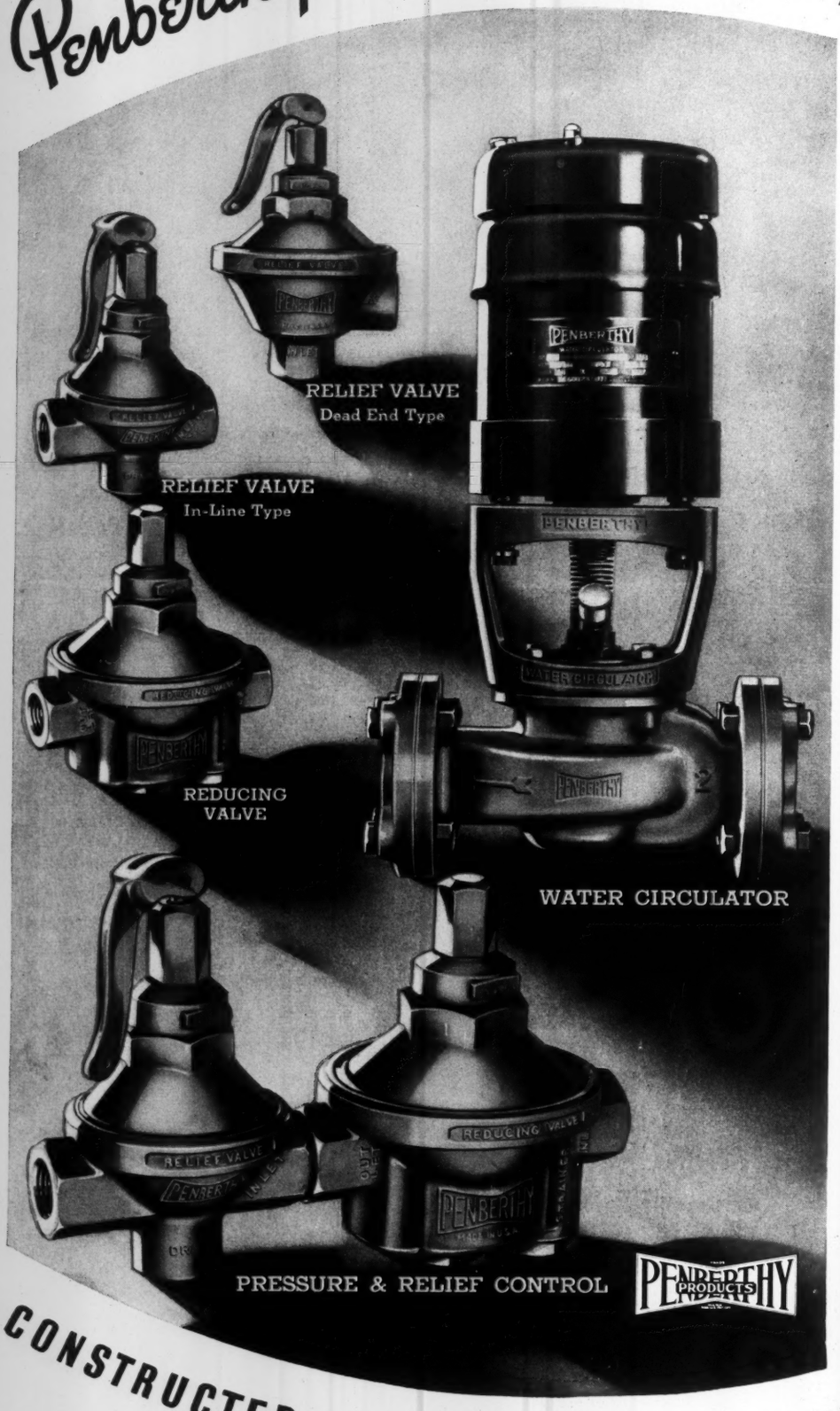

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THE EDITOR'S PAGE

THAT the **directory** of industrial and commercial air conditioning equipment section published in last month's issue of H. P. & A. C. filled a real need is evidenced by the orders for extra copies of that issue which already have been received. . . One reader advises he found three occasions to consult it during the first week after its publication. . . **Suggestions from readers** regarding improvements, additional classifications, etc., will be appreciated, incorporated in any future publication of the directory section.

THE Detroit Edison Company has a way of doing things thoroughly; especially have its engineers contributed to our knowledge of steam **piping design.** . . Readers will find the lead-off article this month a particularly informative one. Written by Sabin Crocker—Detroit Edison engineer, member of H. P. & A. C.'s board of consulting and contributing editors, and an outstanding **piping authority**—it describes the welding of high pressure and high temperature piping for the Connors Creek plant.

THE General Electric air conditioning institute has announced a special **air conditioning school** for power company men at Schenectady starting February 11th, following the sales engineering school for representatives of G. E. air conditioning dealers. . . Kelvinator Corp. recently completed the third of a series of ten-day **air conditioning engineering schools,** at which C. L. Toonder has lectured on theory and applications. . . The University of Illinois now offers **home study courses** in heating, ventilating, air conditioning, and refrigeration. . . Credit earned by correspondence may be applied toward meeting the requirements for graduation from the college of engineering. . . The Oregon Institute of Technology at Portland now offers a thirty-six hour course in the **fundamentals of air conditioning.** . . The second open **forum on air conditioning** for comfort, sponsored by The David Ranken, Jr., school of mechanical trades, St. Louis, will conclude this month—three more meetings (February 11, 18, and 25) are scheduled. . . Westinghouse is holding two **air conditioning engineering schools** for its dealers this month; sound engineering is stressed, and the work includes a study of air conditioning an actual hotel. . . S. F. Myers is now sales manager of the Westinghouse air conditioning department; he participated in its formation two years ago.

A "VERITABLE boon" to investment property owners throughout the country would result if Congress should act favorably on suggestions made by industrial leaders to liberalize the provisions of Title I of the National Housing Act by increasing to $50,000 the limit of **modernization loans** insured by the Federal Housing Administration, according to an FHA release. Under Title I, as it exists, Modernization Credit Plan loan funds may be applied to all types of properties and may not exceed $2,000 for each property. . . The modification suggested at the recent industrial conference of the Federal Housing Administration would enable owners of industrial, store, apartment, hotel and office building properties to obtain loans for modernization and repair in amounts up to $50,000.

CAPACITY and design standards for **steam jet refrigeration** have been developed by the vacuum cooling and steam ejector section of the *Heat Exchange Institute* and are now in effect under the auspices of the Institute. . . A proposed practice for **testing drying equipment** has been completed in tentative form, and criticism and comments are wanted. . . Address C. W. Thomas, *A.S.M.E.* Drying Committee, 29 W. 39th St., New York City. . . The third edition of the commercial **standard on fuel oils** becomes effective February 15; copies of the standard (No. CS 12-35) can be secured by writing the Division of Trade Standards, National Bureau of Standards, Washington, D. C. . . The pamphlet on **suggestions to junior engineers** issued by the *Engineers' Council for Professional Development* contains a questionnaire to aid the young engineer in making a personal appraisal, and a well-selected reading list.

NOTE scribbled on a subscription renewal card returned to our circulation department last month: "This is to me the **best of all** we subscribe to. Would like to renew." . . From a letter written by the chief engineer of a theater: "Having read various copies of H. P. & A. C. and thinking them to **excel as an engineer's magazine,** I would like very much to become a contributor to it."

OVER 300 men, working five days a week, will be kept busy for four months equipping 123 of the **Milwaukee railroad's cars** with air conditioning systems of the steam jet type, according to Geo. B. Haynes, passenger traffic manager. . . Included are Pullmans, diners, observation cars, parlor cars and coaches. . . The C. M. St. P. & P. installed units in 30 lounge and dining cars last year. . . Young Radiator Company has recently added 40,000 sq ft for **increased facilities** for manufacture of heat transfer apparatus and equipment for the air conditioning industry. . . New York's **"better housing, home and building modernization exposition,"** scheduled for the week of March 25, is planned to give consideration to every aspect of the problem of housing.

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The Front Cover—Into a cell 15 ft by 18 ft in a fort at Calcutta 146 English prisoners were thrust the night of June 20, 1756; next morning, 123 were dead for lack of ventilation, excessive heat and humidity. The "Black Hole" tragedy is one of the most striking examples of the effects of poor air conditions, is cited in many a ventilation and air conditioning text. The cover illustration is from a scene in the 20th Century motion picture production "Clive of India."

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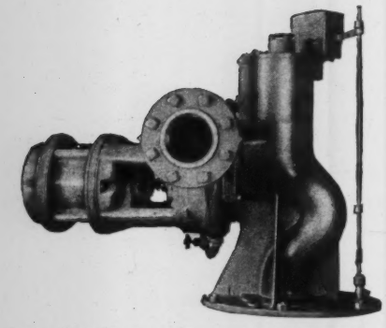

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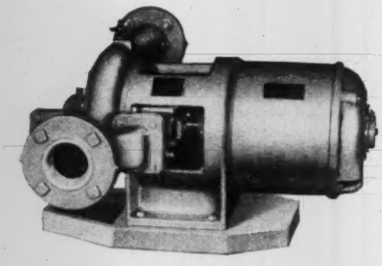

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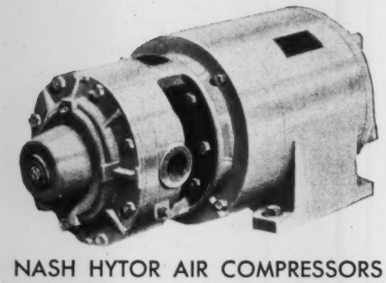

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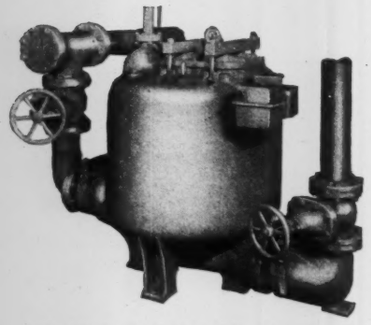

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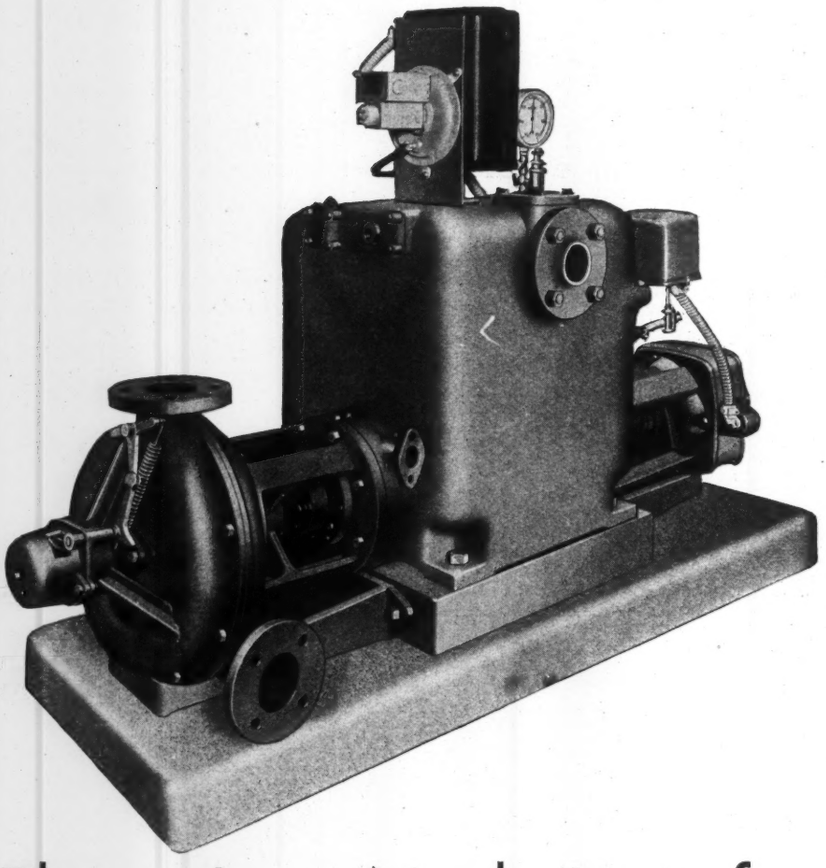

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Heating·Piping and Air Conditioning

February, 1935. *Vol. 7, No. 2*

Welding High Pressure—High Temperature Steam Piping

By **Sabin Crocker***

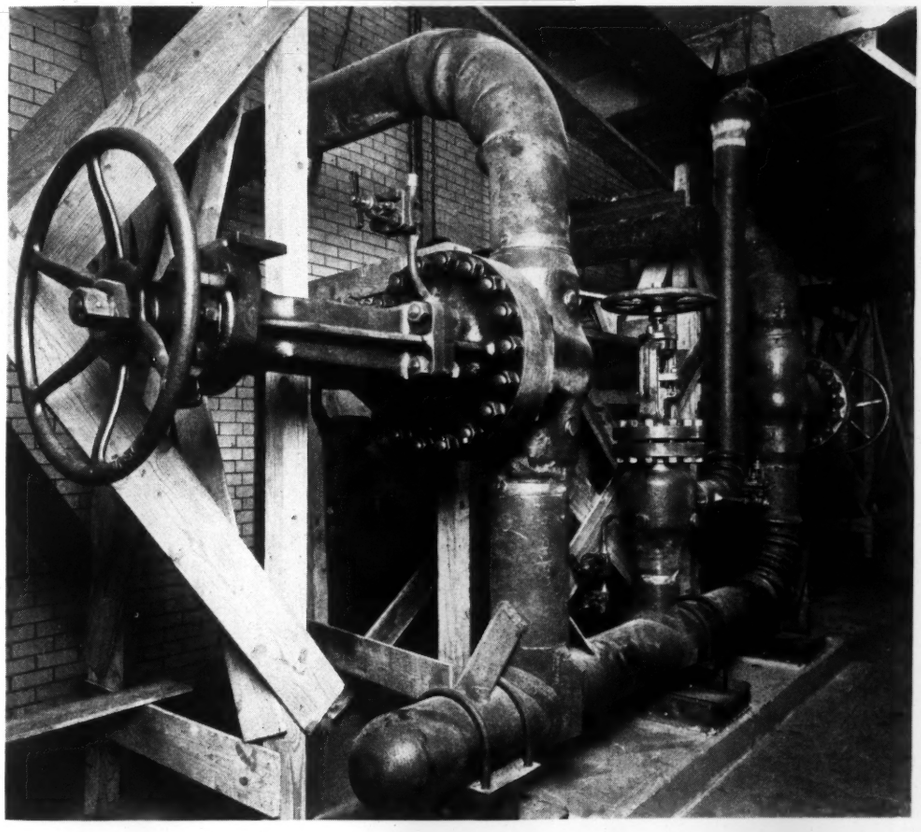


Fig. 1—Main steam cross-over showing valves and manifold

IN rebuilding its Connors Creek plant for 600 lb at 850 F steam service (originally built for 220 lb at 600 F twenty years ago), The Detroit Edison Company decided to solve the high pressure pipe joint problem by using strength welded joints. Having previous experience in the design and operation of 1000 to 1100 F steam piping[1] the Company's engineers were acquainted with the practical manifestations of creep at temperatures above 700 F, and were aware of the necessity either for using extremely heavy bolted joints or for retightening flange bolts periodically in order to keep the joints steam tight. While this tendency for bolts to stretch and let the joints leak can be compensated for, in theory at least, by occasionally turning down the nuts, this constitutes something of a nuisance condition, especially if the bolts must be uncovered to get at them. Furthermore,

*Engineer, The Detroit Edison Company, and Member of Board of Consulting and Contributing Editors.

[1]"High Temperature Steam Experience at Detroit," by P. W. Thompson and R. M. Van Duzer, Jr., *Transactions A.S.M.E.*, FSP-56-9, Vol. 56, No. 7, July 1934.

Several years ago The Detroit Edison Company set out to obtain a background of experience through welding low pressure piping at its plants; recently it has extended its use of welded joints to large size lines for high pressure, high temperature steam.....This article—describing the welding of the 600 lb, 850 F piping for the rebuilt Connors Creek plant—is a thorough and informative explanation of the welding details of this job. Objectives of the design, welding methods and quality control, details of the large joints, and the use of backing rings and shape of the bevel are among the topics covered

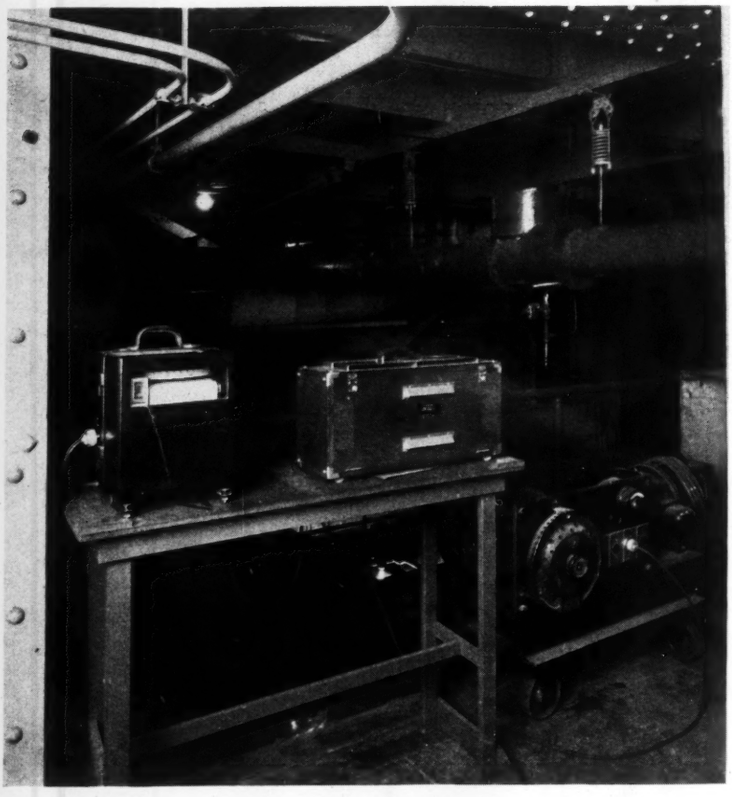


Fig. 2a—The graphical recording device which shows how consistently the welder has performed in laying on a bead

the exact time to anticipate trouble and retighten cannot always be predicted. This—and other considerations—led to the decision to weld the piping.

The generally pleasing appearance of the piping is illustrated in Fig. 1. The relative size of the valve bonnet flanges serves to indicate to what extent the contour of the line itself has been smoothed up through welded construction, while a cast steel substitute for the simple welded manifold shown at the bottom of the picture would be a bulky object indeed by comparison. Incidentally, this particular manifold was shop fabricated so that it could be stress relieved complete in a large furnace. This seemed desirable on account of the large side outlets which required reinforcement and were decidedly awkward for stress relief by the methods developed for line welds. The hemispherical cap closing the end of the manifold in the foreground was later cut off with a torch in order to extend the line to the next unit.

As indicated in Fig. 1 most of the directional changes in 6, 10 and 12 in. high pressure pipe were accomplished with creased bends, with the intention of eliminating any unnecessary joints, while with the smaller sizes and with the low pressure lines ready-made welding ells were used extensively.

Objectives of the Design

Certain definite objectives were established in initiating the design and experimental development with a view to taking full advantage of the possibilities of welded construction. These were:

(a) Line welds to be of the full-strength variety made in position without the need for straps or other reinforcement, and stress relieved in place for pipe sizes 2½ in. and larger.
(b) Valves to have welding ends.
(c) Manifolds to be fabricated from pipe with branch outlets reinforced where required in accordance with Boiler Code rules and stress relieved, preferably in a furnace.
(d) Weld splatter inside the pipe to be avoided through the use of backing rings in pipes 2½ in. and larger where butt welds were employed, and through the use of socket or sleeve welds in pipes 2 in. and smaller.
(e) Welding to be done by duly qualified welders.
(f) All welded lines to be given a hydrostatic and hammer test after erection.

The attainment of the objectives enumerated above required working out numerous novel details of construction, and the development of some new equipment for carrying out the work. The plans as laid for the first section of the rebuilding project worked out most satisfactorily. The first section comprised two 30,000 kw turbo generators and two boilers with auxiliaries. Each boiler is capable of supplying the steam requirements of one main turbine and a 2000 kw house service unit along with an emergency steam driven boiler-feed pump. The initial 30,000 kw unit has been in service since Nov. 1, 1934, without experiencing trouble of any kind with the welded lines. As might be expected, work on the first unit has stimulated thought toward further improvement in design and certain changes in minor details are contemplated for succeeding units.

Welding Methods and Quality Control

Fusion welding of pipe joints in Detroit Edison plants is carried on by the direct-current, metallic-arc process, using coated electrodes and thoroughly chipping and cleaning each bead before applying the next. Since little difficulty has been experienced in making sound line welds in position, no particular effort is directed toward assembling super-long or unwieldy sections on the floor where the work can be rolled. For manifolds having side outlets, however, the obvious advantages of carrying out such work under shop conditions dictates the use of roll welding. Due to the predominance of the personal equation in welding, precautions are taken to avoid fatigue of the welder in carrying on Class 1 work. In this connection it has been found advisable to have all chipping and cleaning done by a helper, principally on account of the arm strain produced in using a pneumatic chisel.

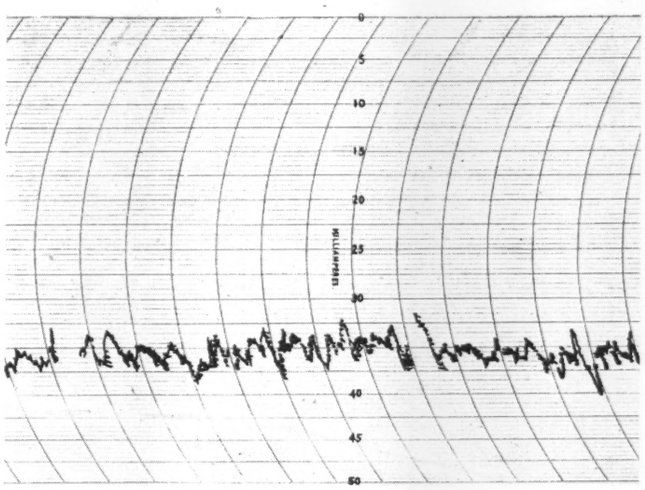


Fig. 2b—Typical chart made by the device shown in Fig. 2a. If in welding the graph swings outside predetermined limits, that portion of the work is subject to suspicion and is due for examination

All welders engaged on high pressure power piping are experienced Construction Bureau employees who have passed the Company's qualification test for Class 1 welding. The initial qualification tests resemble, in general, those specified in the Proposed American Standard Code for Pressure Piping,[2] the principal difference being a larger number of test coupons and somewhat more rigorous requirements with respect to the tensile strength and elongation. Where a welder is continuously engaged on this class of work, and with satisfactory results, it is not considered necessary to requalify him oftener than once a year. The expense of conducting a qualification test is a substantial item, involving considerable material and welding time as well as the cost of preparing test coupons and examining them. Periodic requalification tests for a welder who has already qualified and been engaged on pipe joint welding need not be so extensive as the original qualification.

As pointed out above it is essential that a welder demonstrate his ability through exacting qualification tests before being allowed to work at all on pressure piping joints. These tests give general assurance of ability to do the work, but, on account of the human factor involved in manual welding, do not necessarily prove that each weld made is the equal of that done on test. Hence some adequate method of quality control was sought, either through a non-destructive examination of each completed weld if such proved practicable, or through some system of supervision which would give a continuous graphical record of the conditions under which weld metal was deposited. X-ray and gamma-ray methods were considered and discarded on the grounds of being unsuited to field work and inapplicable to branch connection welds. A magnetic method of examination was experimented with and found unreliable in that it failed to detect certain serious flaws purposely produced in a specimen intended for examination. About this time a graphical recording device[3] came to the attention of the Company's engineers, and after some investigation was adopted as offering the greatest promise of a satisfactory means of controlling weld quality.

This device is an electrical recording instrument which employs a three element vacuum tube to take account of the ratio of arcing time to short-circuiting time in the process of depositing each globule of weld metal. Since this ratio should be essentially constant for a given size and type of electrode, the graphical record serves to show how consistently the operator has performed in laying on each bead. Satisfactory limits for the graphical record produced when using any given electrode are set initially through observing the range of chart values obtained while doing test work which is known to be satisfactory. If in actual welding the graph swings outside the predetermined limits, that portion of the work is then subject to suspicion and due for examination. Any flaws in the bead thus become apparent as the work proceeds and can be chipped out or otherwise corrected while the bead is still exposed without having to wait for an X-ray or other examination of the completed weld. Welders ordinarily check the record as they finish each bead. The fact that the welder works under the constant supervision of a graphical record and cannot hide his mistakes is considered one of the principal advantages of the instrument. A photograph of a portable outfit of this kind and a typical chart are shown in Figs. 2a and 2b.

Details of Large Joints

Several years ago The Detroit Edison Company set out to obtain a background of experience through welding low pressure piping joints around its plants. In extending the use of welded joints to large size lines for high-pressure high-temperature service the Company's engineers felt that the technique of the art and the skill of the welding personnel should be developed to the point where a simple butt welded line joint would be sufficient in itself without resorting to reinforcing straps or backing up flanges. Further, in making a complete welded job the engineers desired to use welding-end valves involving pipe-to-casting welds in addition to the usual pipe-to-pipe welds. This part of the problem was rendered more difficult by the fact that it seemed advisable to use some form of low alloy steel rather than plain carbon steel for the valve bodies on account of the neces-

[2]See Heating, Piping and Air Conditioning, July and August 1934 issues, "Requirements for Welded Piping Joints", pp. 298 and 339 respectively.

[3]"Evolution of the Arcronograph", by Bela Ronay, *Journal* of the *American Society of Naval Engineers*, August 1934.

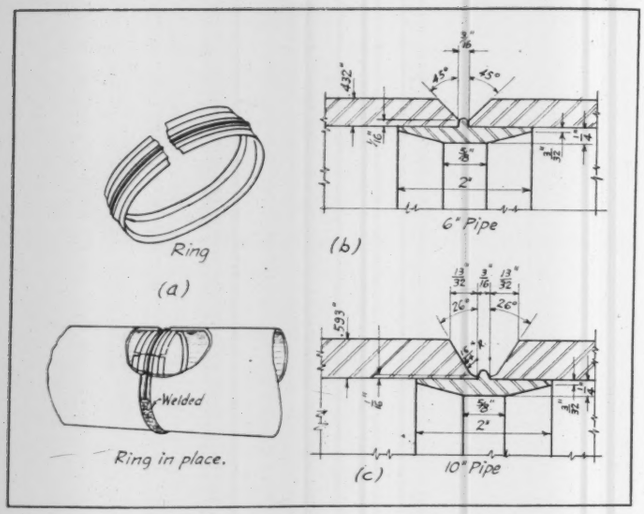


Fig. 3a—The type of ready-made backing ring used

Fig. 3b—Welding vee and backing ring for 6 in. pipe

Fig. 3c—Welding vee and backing ring for 10 in. pipe

sity for tapering down the welding ends to a wall thickness approaching that of the pipe.

Before definitely adopting welded joints for the Connors Creek job it was decided to conduct some experiments of a laboratory nature on full size joints of the kind contemplated as a necessary step in going from the low pressure work previously done to the maximum conditions of the new project. This experimental work, carried out in the summer of 1933, proved that the design of joint and the materials used were satisfactory for the purpose, and that the Company's qualified welders were equal to doing this class of work. A report of this investigation was made in a paper presented at the 1934 fall meeting of the *American Welding Society*.[4] Both pipe-to-pipe and pipe-to-casting welds were included in the investigation which covered physical properties at room temperature, short time tensile properties at 850 F, rate of creep at 850 F for four loadings ranging from 7,000 to 15,000 lb per sq in., and microstructure of the metal at a series of points in the weld and in the parent metal, both casting and pipe, adjacent to it. A check was made also to verify the absence of air hardening, temper embrittlement, and excessive porosity in the weld metal.

In the welding of thick walled pipe by the coated-electrode metallic-arc process, experience has indicated the advantage of laying in a relatively large number of thin layers rather than attempting to fill up the vee with fewer thick layers. Some difference in technique is required for position welding where the pipe axis is vertical rather than horizontal. For instance, with horizontal pipes having a ½ to ¾ in. wall, some six to twelve layers are desirable with the beads laid to and fro across the vee to form each layer. With a vertical pipe of corresponding wall the same number of layers would be used, but in this case there might be fifteen to twenty individual beads laid in the vee as separate rings. The use of a multiplicity of layers aids in securing a sound weld both by minimizing the tendency for porosity and by a refining of the grain structure afforded by the heat of each successive layer.

[4] "An Examination of Welds Made Under Field Conditions for High-Pressure, High-Temperature Steam Station Piping", by A. E. White, D. H. Corey and C. L. Clark, *Journal* of the *American Welding Society*, September, 1934.

Backing Rings and Shape of Bevel

The necessity for holding pipe ends in alignment at the beginning of the welding operation coupled with the desirability of avoiding weld splatter inside the pipe and at the same time obtaining full penetration to the bottom of the vee all pointed toward the use of backing rings in medium and large size pipes. While it was felt that the presence of backing rings would not appreciably restrict flow in pipes of 2½ in. nominal size and larger, such devices assume rather serious proportions for sizes 2 in. and smaller. Hence, for these small pipes, it was decided that the aims enumerated above could be realized to better advantage by substituting fillet welds in conjunction with sockets or external sleeves. The internal type of backing ring adopted is shown in Figs. 3a, b, and c, while the sockets and sleeves will be discussed later.

The backing rings shown are a ready-made variety in the form of a split band, somewhat tapered at the edges, and having a central ridge which helps in aligning the pipe ends and gives a nucleus for fusing in with the first bead. A home-made variety of backing ring was tried also, but found somewhat inferior for high pressure joints. This type was a split ring which was rolled up out of flat strip without joining the ends together before inserting in the pipe. The disadvantages of the home-made ring are that it requires more tack welding to locate it in the pipe and the central ridge is missing. The added time required in the field with home-made rings is deemed to more than offset the extra cost of ready-made rings.

With pipe walls up to ½ in. thick the conventional 45 deg bevelled end shown in Fig. 3b was used. In the case of heavier walled pipes, however, it was felt that the double 45 deg bevel left too much material to be deposited during the welding operation and, after some experimentation, it was decided to use the spread U type of bevel shown in Fig. 3c for pipe walls over ½ in. thick. The details shown in these sketches are typical of what was adopted for one size pipe in each thickness class. Standard sheets showing similar details were drawn up to cover the whole range of pipe sizes involved.

Where welding end valves were used in sizes 2½ in. and larger, it was necessary to taper down the wall thickness of the valve on the outside adjacent to the weld as shown in Fig. 1. In this way it was possible to have the thickness of the welding end approach that of the pipe, and at the same time have the bore of pipe and valve coincide.

[Mr. Crocker's next article will consider the stress relieving of welds, installation of flow nozzles in an all-welded piping system to prevent distortion and the details of the welded joints in the smaller high pressure piping in this project, including welded sleeve couplings, socket fittings, and the attachment of small pipes to large pipes or castings.—The Editor.]

CHOOSING *the right* AIR CONDITIONING SYSTEM

By **A. Warren Canney***

Part 3—Basic Differences Between Central Station and Unit Systems

BEAR in mind that this series[1] is confined to the practical business of applying air conditioning for the welfare of building occupants; that a predetermined standard of atmospheric conditions is substantially universally applicable (with the exception of different variations for local acclimatization factors); that comparative cost has no direct bearing on area or cube served; and that we are primarily concerned with establishing a reference for those who have, or will have, the responsibility of acquiring a successful air conditioning system for a particular building.

Choice of an Air Conditioning Method

The choice of two or more ways of accomplishing or procuring something in exchange for money is usually contingent on the comparative total costs for ownership, which include planning costs, initial expenditures, chargeable operating costs, depreciation, obsolescence, taxes, insurance, direct and indirect savings accrued, direct and indirect profits acquired, interest money chargeable, and intangibles.

This leads to a critical point in our study, which has to do with the viewpoint of the buyer. Rarely do astute buyers reach a decision without first weighing relative merit. Invert this thought—that is to say, assume two air conditioning methods have identical merits as to *atmospheric* results. While this is not always the case, it is perfectly and readily possible. But *it is next to impossible to set up two air conditioning METHODS for price comparison with all other things equal.* You can't compare two new golf balls merely by looking at them.

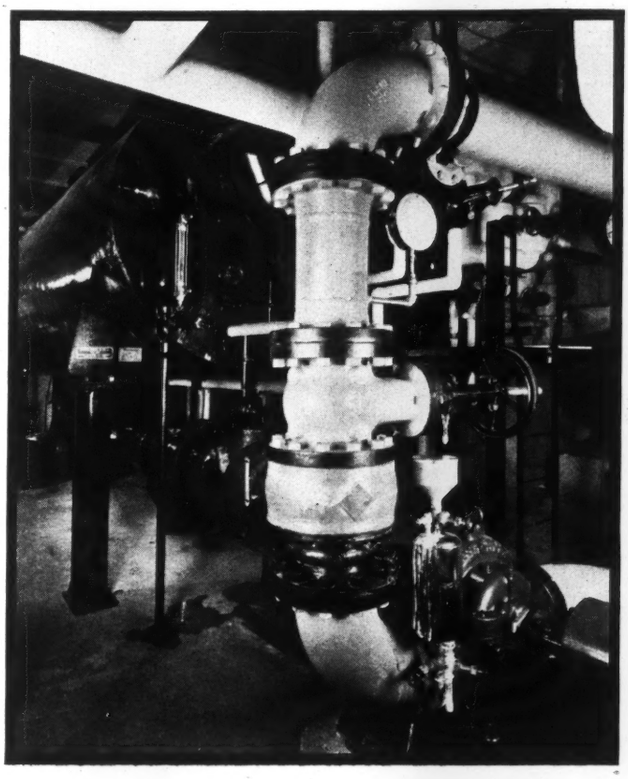
Each air conditioning method has its advantages and disadvantages. Price and method sometimes live very unhappily together. From an owner's standpoint, there is no such thing as the perfect air conditioning system, for equipment space is required in his building somewhere. Architecture, attendance, servicing—something has to be modified (outside of the money item) to own air conditioning.

In addition to assuming that identical atmospheric results will be had, assume that two different methods —not merely considered but competently studied—both show what amounts to identical ownership costs. You own a department store, let us say, and your engineer assures you that either method will be equally satisfactory; he concludes for one reason or another that the system involving an alteration in the appearance of the ceiling is the system you should have. Let us say he had plastered-in ceiling units in mind.

He, as the consultant, has reasoned out this recommendation to the best of his ability. He figures (based on your confidential business information) the value of the sacrifice necessary in basement store space for a central plant and decides that, although an even break

*Engineer in charge of Air Conditioning, Staff of Clyde R. Place, Consulting Engineers.

[1]Two previous articles have been published, in the November and December, 1934, issues of H. P. & A. C.



Steam jet refrigeration machine at La Maison Française, Rockefeller Center

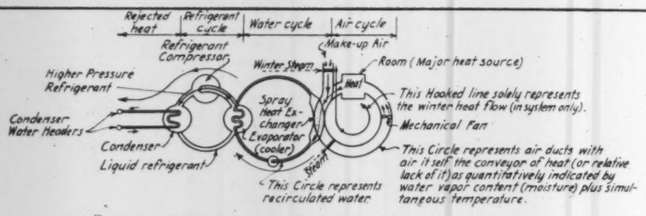

Rejected heat
Refrigerant cycle
Water cycle
Air cycle
Refrigerant Compressor
Make-up Air
Winter Steam
Room (Major heat source)
Higher Pressure Refrigerant
Heat
This Hooked line solely represents the winter heat flow (in system only).
Condenser Water Headers
Spray Heat Exchanger Evaporator (cooler)
Mechanical Fan
Condenser
Liquid refrigerant
This Circle represents air ducts with air itself the conveyor of heat (or relative lack of it) as quantitatively indicated by water vapor content (moisture) plus simultaneous temperature.
Steam
This Circle represents recirculated water

Fig. 1 – Outside arrows and arrows from room show heat path for any air conditioning system utilizing mechanical refrigeration. (For steam, jets the recirculated water becomes the refrigerant in the refrigerant circle).

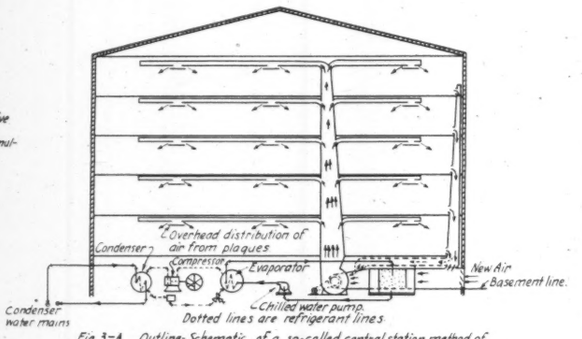


Fig. 3-A Outline-Schematic of a so-called central station method of air-conditioning (heaters and miscellaneous apparatus omitted for clarity) – could be any capacity. Note:- Rentable values for apparatus and duct shafts selected at minimum.

Fig. 2 – A simplified diagram of the same "Summer" process as in Fig. 1 – but eliminating the recirculating water and sprays therefor by placing evaporator in path of air with metallic tubes having considerable surface area compactly exposed to air; referred to as direct expansion (of refrigerant.)

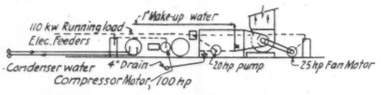


Fig. 3-B 100 Ton Central Plant. Outline of power and water auxiliaries – 2000 Sq Ft Floor Space 12 Ft headroom

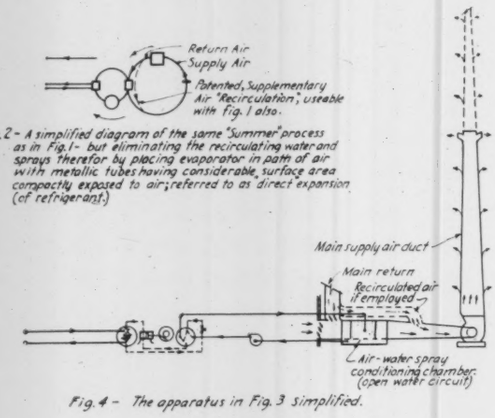

Main supply air duct
Main return
Recirculated air if employed
Air-water spray conditioning chamber (open water circuit)

Fig. 4 – The apparatus in Fig. 3 simplified.

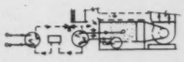


Fig. 5 – The apparatus in Figs. 3+4 compressed to preferred minimum positions.

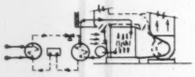


Fig. 6 – Metallic surfaces for heat absorption only per this diagram replacing sprays in air-path. Same as Figs. 3, 4, +5 but a closed chilled water circuit. Functions exclusively as a (Summer) heat absorption system as shown. Operation characteristics also modified from Figs. 3, 4, +5. See Text.

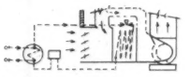


Fig. 7 – The same functional equipment as in Fig. 6 – but utilizing direct expansion and no means for humidification added in diagram, recirculated water eliminated as in Fig. 2. Dependent on method of adding humidification, control during spring and fall seasons may not be obtainable.

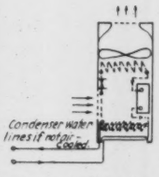


Fig. 8 – This is substantially Fig. 7 standing on end and behold the rudiments of a unit air-conditioner. (Humidifying sprays etc. not shown)

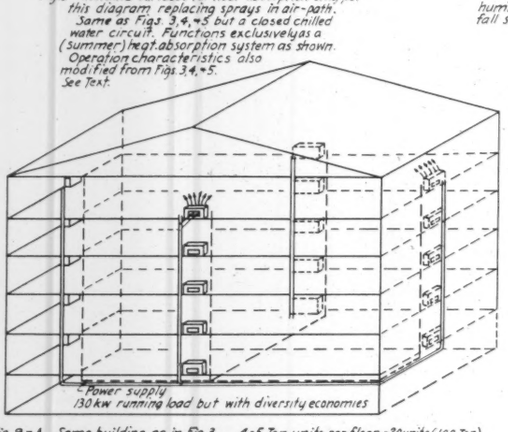


Fig. 9-A Same building as in Fig. 3 4-5 Ton units per floor +20 units (100 Ton) This diagram for self-contained equipment. Fresh air intakes pierce exterior wall (for proper comparison with fig. 3.)

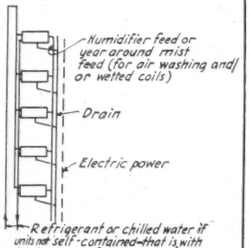

Humidifier feed or year around mist feed (for air washing and/or wetted coils)
Drain
Electric power
Refrigerant or chilled water if unit not self-contained – that is, with individual refrigeration units.

Fig. 9-B

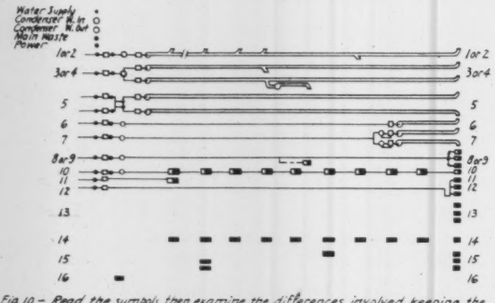


Fig. 10 – Read the symbols, then examine the differences involved, keeping the primary sources of utilities and mechanical services in the same relative position as shown in scheme #1. The idea is to take all the equipment and inter connecting piping etc. and, for simplification of principle only, to string it out in a straight (imaginary) line. Do this for the proposition at hand.
Note: (Other major combinations to be discussed in later articles. This is for background purposes only, for assembly and standard product comparison.)
(Return piping and ducts not shown for ease of comparison.)
1-7 = Central station with fresh air intake properly and conventionally provided
8-16 = Combination unit and central station or unit systems only with or without fresh air intakes.

Key To Symbols

- •□• Complete refrigeration with evaporator (right dot).
- •□ Refrigerant condensing equipment (no evaporator this point).
- ○ Water pump.
- □ Air to water or air to refrigerant conditioning chamber.
- Fan
- = Air duct.
- Unit air-conditioner with evaporating coils but no refrigerant condensing unit within casing.
- Complete self-contained unit air conditioning unit (with humidifier and controls etc. for comparison.)

(■ or ■ may be with or without duct work)

was indicated, that the revenues which might be lost might possibly be financially injurious in the long run, because he knew you were pushing the basement department through expensive advertising.

Your department store is the finest in town—not alone your conviction, but by being the most profitable in the locality—and it is definitely the most modern. In fact, you built it but a few years ago and not to have air conditioned it then was (you have many times thought) a sad oversight.

The next morning you telephone your engineer first thing, because when you went home last night you began dreaming of the fine business and store you had instituted. You gave the engineer your decision. It was simple. You wouldn't have *that* main floor altered in its appearance if the equipment were a Christmas present. The architect had hit the right note, your every cent of capital plus heavy borrowing had put up a store the appearance of which had much to do with public favor, and good trade. No sir, you'd not alter that ground floor one iota. You wouldn't put anything there, no matter how cleverly disguised, at half the price. The public liked it as it is, and you knew the subtleties of your business.

And now you have the story of how, in essence, air conditioning buying decisions often are made.

The well founded reason to be remembered for this is that a choice of air conditioning method exerts a profound influence on appearance and even building design itself, and therefore, interior architecture. This is more so with air conditioning than with any other mechanical building service.

Fundamentals Involved in a Choice

An explanation of the fundamentals involved in a choice will be more helpful than cut and dried (not always cut and *tried*) assertions, which usually undergo sad misapplications somewhere along the line:

The designer must be sure that the methods compared will fulfill the atmospheric standards set, both with equal comfort and health satisfaction. If not, he must balance "result satisfaction" against cost (see the two previous articles of this series).

A searching cost analysis based on experience is then required. The factor of desirability of method will then win the toss-up whether ownership costs are the same or not.

But the acquirement of air conditioning is not properly (nor in practice) so abrupt a process. It is a matter of evolution, of study, of considerable interchange of information between owner and engineer.

One experience of the author will serve to show how the tables can be turned. On one job a portion of a structure had been built with the result, as in most pre-existing buildings, the air conditioning had to be designed around the structure instead of the two co-ordinated, as planning new building permits. There was no choice in the matter—a certain projection from the ceiling was necessary to introduce air into the room, and that's all there was to it.

A flush ceiling was impossible, and the peculiarities of the space precluded air supply any other way, as the owner well knew. Well, the owner was furious, outraged, to think his beautiful ceiling would be ruined. He had not known what air conditioning would involve, had given it no thought.

The upshot was that the treatment was so harmonized in contour, despite its bulk, that it is never noticed, but considered (if considered at all) deliberate architectural treatment. The author proved this by checking up with dozens of visitors.

Thus, varied circumstances make, in a sense a veritable football out of the question of method comparison for universal application.

The question, "Which will be the cheaper for my premises, a central station or a unit system?" as a basis for a decision for universal application is an absurdity. Moreover, this classification needs to be clarified, which later paragraphs will do.

For simple conditions on a straight engineering basis, there isn't considerable difference in initial cost for central station or units between 25 to 75 tons. But who buys mechanical equipment with an eye solely to initial cost? Only foolish people.

The Process of Air Conditioning

Before proceeding to the differences between the two extremes as represented by "units" and "central station" systems, it seems advisable to explain more fully the essential air conditioning processes and functions desired—irrespective of method.

Referring to Fig. 1, air conditioning comprises essentially a series of heat transfer processes involving room air heat content, outdoor air heat content, the heat gains or losses in or to the system itself and the heat content (in summer) of the ultimate heat-receiver. The difference in the heat level of the latter, usually "city water" (and quite often the outdoor air itself) establishes the effective summer heat absorption capacity of the system for given installation requirements, usually effected by mechanical refrigeration.

Due to the fact that this heat supply or absorption process begins with the occupants themselves, a balance is required between ordinary (sensible) heat liberation and skin surface moisture emission which tends to increase the vapor content (latent heat) and therefore the relative humidity in the air conditioned rooms. Hence, for an air conditioning process to become worthy of the title "system," the process must counteract the emission to or losses from the rooms due to *both* the sensible heat and that which is contained in the evaporated moisture, this latter being water in vapor form mixed mechanically with the other constituents of the atmosphere (oxygen and nitrogen), which latter we will simply label and refer to as "the gas" because neither condenses within the temperature ranges involved. On the other hand, the vapor is condensable as *the* vital process of air conditioning. Balancing these two forms of heat is the essential purpose of an air conditioning system.

The infiltration of air from outside, or the loss of air from the premises conditioned, may mean an increase in the vapor and a simultaneous decrease in the heat of the gas. Both forms of heat are not always lost or gained to the room air at the same time. We want these heat exchanges and transfers to take place from or to the room air, the vapor added or removed as required, and the heat in the gas added or removed as required to maintain a pre-set temperature as indicated by the dry bulb temperature and the vapor content as

specified by the humidity relative to that same dry bulb temperature.

Now, to do these things, we must "operate" on the air, so to speak, and if we are to classify methods, we might well start here, for at this point certain flexibilities obtain that make equipment differ.

Thermally, a water spray is the only year 'round method for producing relative humidity control, indirectly or directly, and temperature control simultaneously. This is supplemented by volume control and air heaters, as the remaining essentials for year 'round control *for independently counter-balancing varying heat and vapor content changes.* Specifying any two of temperature, relative humidity, dewpoint (absolute humidity) or wet bulb establishes the datum for both forms of heat levels.

The great transition in air conditioning practice on a merchandising scale came when tubes with extended surface fins similar to and not infrequently identical to that used for steam-to-air heaters were used for the simultaneous removal of gas heat and vapor content. These metallic surfaces however are not seasonally nor functionally universal, as they require, in addition to the winter heaters and volume control, some means of humidification, best effected with a spray. Street main pressure is sufficient to do this with an almost negligible water quantity.

This system therefore enables the elimination of a pump and water piping, as sketched in Fig. 2.

There is really no limit to the size of an air conditioning plant possible with metallic surfaces, and there is ordinarily but little difference in space requirements. Thus, the rudiments of the standard product unit air conditioner is readily transformed for central station work by using standard elements for job assembly, such as fans, filters and so forth.

On some installations the standard product type of unit doesn't stand a chance. Space and appearance in the quarters conditioned are simply at too high a premium. No engineering problem at all. But this works both ways. The central station or small water spray job hasn't a remote possibility of application under many conditions.

In the diagrams, compare, for rough study, Figs 3a and 9a, then Fig. 3b with Fig. 4b. Note the difference in auxiliary water and power services.

Figs. 4 to 8 show a transition which is actually historical. Metallic surface for air heat absorption in central systems came long before the unit air conditioner, although the latter has prompted the manufacturers of extended surface to conquer bigger fields.

The one big point to be obtained from the above is that *there is but one major difference between central station and unit air conditioning methods,* and this difference is not a matter of heat-transfer method but use or non-use of duct work. Whether central station or unit, there is one thermal difference which may or may not be a major difference, and that is that with a year 'round water - spray - humidifier - dehumidifier - cooler, temperature and relative humidity can be independently controlled, whereas with extended surface the proportion of gas heat to vapor removal is both limited and variable after the installation is made. These units are therefore selected to give the maximum proportion of vapor to sensible gas heat removal under given conditions and are mostly applied with thermostatic room dry bulb temperature control only, for summer work.

Proper design, however, permits keeping the relative humidity within desirable limits. The limited ability or inability to produce relative humidity *control* simultaneously with temperature control; its incapability of utilizing outdoor air for spring and fall relative humidity control; plus the necessity of a supplementary humidifier for winter constitutes the three basic differences between metallic surface and sprays in the main, although the appellation of central station is legitimately applicable to metallic extended surface cooling when using distributing duct work, standard products or not, as these become in fact—despite diminutive size—central station systems, and run in capacity between three and fifty tons. Under these conditions no thermal distinction essentially applies and the upper limit of tonnage is technically unlimited.

This provides two simple basic classifications for further study, applicable to all air conditioning practice, namely: (1) central station: as indicated by the use or non-use of distributing duct work, *or* units (without duct work) and, (2) the major thermal element used for processing the air thermally as: sprays alone *or* metallic surfaces.

One other point deserves mention here: The emphasis on summer conditioning even for commercial applications is greatly unbalanced and overly emphasized at this time. Few people have been in a place which has a reasonably accurately controlled temperature and relative humidity in winter, with just a barely detectable amount of uniformly diffused air movement with the supply air containing an adequate amount of outdoor makeup. The sensational difference as opposed to the usual indoor atmosphere in winter is astonishingly delightful. Equal emphasis should therefore be put on winter air conditioning.

Later, we will set forth fundamental technical principles which influence the choice of air conditioning method, with special reference to central station systems.

"Certified" Air Conditioning

"CERTIFIED" air conditioning is featured in an advertisement to appear in the February issue of the Chicago classified telephone book which reads as follows:

"To safeguard the health and safety of the public, standards for comfort air conditioning have been developed. These standards are the result of a study by a committee composed of representatives from:

Consulting Engineers Division of the Western Society of Engineers.

Chicago Master Steam Fitters' Association.

Ventilating & Air Conditioning Contractors' Association of Chicago.

"These standards define what complete air conditioning means, and outline reasonable minimum requirements for temperature, air motion, moisture control and dust removal.

"They define the principal legal requirements and safety provisions.

"All proposed air conditioning installations shall comply substantially with these standards in order to be certified."

For Better Plant Operation—

METER YOUR PIPING SERVICES

By **F. W. Rabe* and Hugo Reichenbach†**

Anheuser-Busch keeps track of the services piped to various departments to permit proper allocation of costs and aid efficient operation. A complete system of metering was installed recently for the ammonia and for steam . . . This article describes the 'why' and 'how', includes practical pointers on metering these services

THE value of metering industrial piping services is so well established that little need be said here as to the usefulness of meters. This is particularly true in a plant as diversified as the Anheuser-Busch brewery, where many departments make common use of steam, refrigeration, hot and cold water, etc. The proper allocation of costs can only be done if the quantities of each are accurately metered. In addition, by the use of meters, the daily operation of departments can be analyzed to find ways and means to check or reduce operating costs.

It was therefore only natural that a complete system of meters was installed when extensive alterations were recently made at this plant.

Metering Ammonia to Three Departments

There are three departments using ammonia refrigeration—the ice plant, the cereal beverage department, and the yeast department. The liquid ammonia to each is metered. As a check, the total ammonia to the header from which these departments are supplied is metered. All the meters are of the integrating and recording type, except the total ammonia meter which has in addition a 15 in. indicating dial. The ammonia meters, together with steam and water meters, are mounted on a steel panel behind which the meter bodies are located.

Our previous experience has shown that metering ammonia has some peculiarities which preclude the possibility of going about the installation of meters in any haphazard manner.

First to be given consideration were the metering elements. Due to the fact that liquid ammonia will flash into gas if there is a reduction in pressure over the liquid, a meter was selected which operates on a very low differential, not over 4 in. of mercury. However, no matter how small the differential the liquid ammonia must be sub-cooled about 10 F. The small differential reduces the sub-cooling to a minimum.

Liquid ammonia trapped in the suction line accumulators is used to sub-cool the ammonia liquid to be metered. The accumulators, being at a higher elevation, drain continuously into the cooler. The cooler is equipped with temperature and pressure recorders to provide a record of how much the ammonia is sub-cooled.

The load at this plant varies considerably over a rather wide range in a comparatively short time, due to the necessity of quickly cooling great volumes of beer and water and because of the intermittent operation of automatic controls. Such fluctuations make it necessary to have a meter that integrates continuously rather than intermittently.

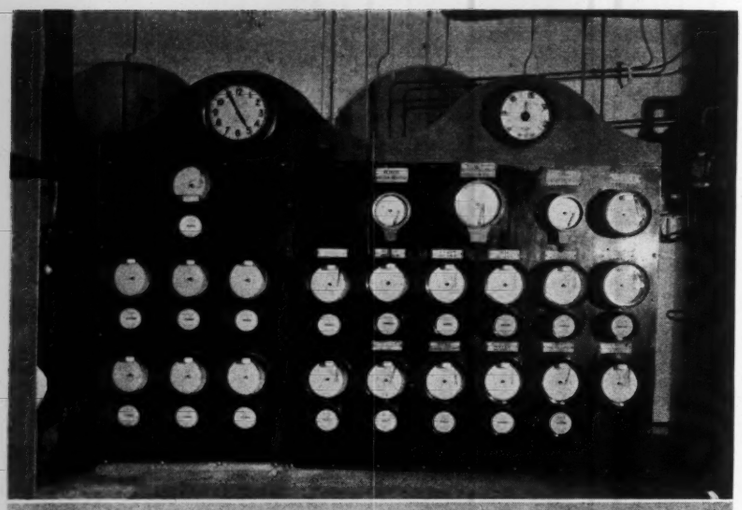
Despite the low differential, the total meter might flash a small amount of ammonia into gas due to the rapid and wide fluctuations. For this reason the total meter orifice was placed in a vertical line so that any gas which might form could very easily pass off, thereby avoiding trapping and consequently the recording of untrue differentials. Suitable check valves are incorporated in the meter body to prevent blowing the mercury over when there are wide fluctuations or when the meters are shut off.

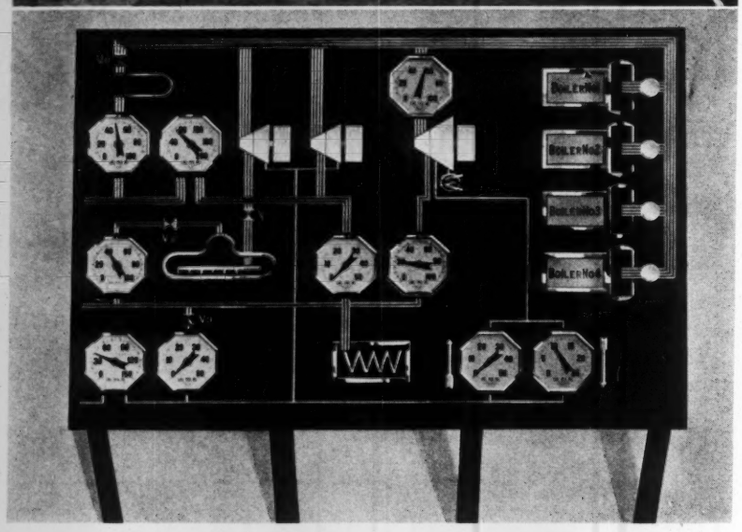
There will always be some liquid ammonia above the oil in the lines from the orifice to the meter, and because of the unstable character of liquid ammonia when pressures vary, suitable means should be available for balancing the oil columns over the mercury as the amount of liquid ammonia varies from time to time. It is very important to use oil having a very low cold test, at least 20 F. If this precaution is not taken, the increase in viscosity of the oil at low temperatures will cause untrue metering.

The oil reservoirs are placed close to the orifice plate so that the lines from the orifice plate which contain ammonia will be as short as possible. Then if the reservoirs and lines are well insulated, the small amount of heat leaking through the insulation will be carried into the main line by conduction through the pipe rather than pass into the ammonia, causing it to vaporize.

It is important to have all meter parts of iron or steel since copper, brass, and bakelite are attacked by ammonia.

*Assistant Chief Engineer, Anheuser-Busch, Inc., St. Louis, Mo.
†Engineering Department, Anheuser-Busch, Inc.





ABOVE

Fig. 1—These meters keep track of the ammonia used by various departments requiring refrigeration, permit proper allocation of costs

BELOW

Fig. 2—This diagrammatic steam meter board shows the relationship of each piece of equipment, aids efficient operation

The meters record pounds of ammonia, while the common unit of refrigeration is the so-called ton of refrigeration. Hence, it was necessary to prepare curves showing the refrigerating effect of one pound of ammonia at various combinations of suction and head pressures. This is a simple thermodynamic calculation independent of the efficiency of the manner in which the liquid is used.

In the boiler plant there is, in addition to the metering, the problem of operating efficiently. Efficient operation can only be made possible by the proper inter-relation of the four pressures used in this plant. Essentially, the plant comprises four high pressure boilers, three mixed pressure turbines, one of which can operate condensing, a steam accumulator, a high pressure feed-water heater, and a desuperheater.

The operation of these units can be determined at a glance by reference to a schematic flow board having indicating meters to give the quantities involved. Each grouping of copper bars on the board represents a different pressure and properly connects each piece of the above-mentioned equipment.

It can be easily seen that after a few minutes study each piece of equipment can be so regulated that it is functioning in a manner that best fits the requirements of the plant for steam and power. Each indicator has a recorder and integrator, all being grouped on a separate panel.

While the piping services of many plants are not as complicated as those described here, the operation of any plant can be more accurately controlled when its functioning can be seen as a whole rather than as so many scattered units.

Pipe Insulation Pays

IT is not generally realized how great is the loss of heat from an uncovered steam pipe or boiler surface. The table shows the rates of heat loss per square foot of pipe surface per degree Fahrenheit difference in temperature pipe to air through a range of temperatures; also the equivalent rates of heat loss through an efficient insulating material, assuming in each case an air temperature of 70 F.

Temperature of Pipe	100	200	300	400	600	800	1,000
Loss of heat from bare pipe per sq ft per hr per F, diff. of temp. pipe to air, Btu.....	1.95	2.27	2.75	3.37	5.06	7.12	9.61
Corresponding heat loss with 1-in. insulation	0.40	0.42	0.45	0.48	0.55	0.64	0.75
Corresponding heat loss with 1½-in. insulation	0.31	0.33	0.35	0.37	0.43	0.51	0.60
Corresponding heat loss with 2-in. insulation	0.25	0.26	0.28	0.30	0.35	0.41	0.49

Applying the figures shown to a concrete example, we see that the heat loss from 100 sq ft of uncovered steam pipe (equivalent to 95 lineal feet of 4-in. O.D. pipe) carrying steam at a pressure of 235 lb per sq in. in gage (corresponding temperature 400 F) will amount to 111,210 Btu per hr. By the use of an insulating material having an efficiency of 91 per cent under these conditions, the heat loss can be reduced to a figure of 9,900 Btu per hr, showing a saving of 101,310 Btu per hr.

Extending this figure still farther, and assuming that the steam is obtained from a coal-fired boiler having an efficiency of 70 per cent, working 8 hours a day on 250 days a year and burning coal having a calorific value of 11,500 Btu per lb, we see that the equivalent wastage of fuel will amount to 11¼ tons per year. Further examples under similar conditions but with higher initial steam temperatures will afford the following results:

Temperature of Steam, F	600	800	1,000
Bare pipe loss per hr, Btu.....	268,180	519,760	932,170
Insulated pipe loss per hr, Btu.....	18,550	29,930	47,530
Saving due to insulation per hr, Btu.....	249,630	489,830	884,640
Coal equivalent, tons per annum.....	27.75	54.5	98.25

Thus it will be seen that the initial outlay on the insulation can be recovered on the saving of fuel within a few months of operation of the plant.

From a paper by Cyril S. Woodward read before the Ceramic Society, London, England, and published in the *Journal* of the *Institution of Heating and Ventilating Engineers.*

Get Conditioned Air to the *Occupant!*

Why spend money to condition the air for a theater unless that air gets to the occupant for whose benefit it has been treated?, asks D. D. Kimball* the author of this article . . . . . Based on his survey of 76 motion picture houses, he discusses here air distribution, location of inlets and outlets, spring and fall operation, equipment accessibility, and amount of cooling required in a theater.

THIS discussion of the air distribution in theaters is based on a recently completed survey of the mechanical services in 76 motion picture houses in the eastern part of the United States. The results of this survey and the conclusions based upon them have been considered in two previous articles.[1]

Air Distribution in Theaters and Auditoriums

There has been a very general adoption of the so-called "plenum" system of theater ventilation, by which is meant a system which maintains a slight excess pressure within the theater proper as related to the outside atmospheric pressure. The advocates of such a system have overlooked certain important elements thereof, in the author's opinion.

Let us assume that a ventilating or cooling system is designed to provide for each occupant of a theater a certain definite quantity of air, say 30 cfm. At great expense for equipment and its operation this air is washed, filtered, heated in the winter, cooled and dehumidified in the summer and forced into and through the theater on the "plenum" principle. This air is thus treated for the benefit of the occupants of the seats on the various floor levels. But in accordance with the theory upon which this system is based a considerable portion of this expensively treated air is expected to (and does) leave the theater through the entrance doors, exit doors, and various passages, plus relatively large quantities through the proscenium, etc., without any benefit whatever to the patrons, unless it be the prevention of drafts which can be otherwise prevented more effectively and cheaply.

If we are going to provide 30 cfm *per person* let us see to it that the occupants of the seats get 30 cfm, or let us state the volume of air per person per minute in accordance with the facts, *i. e.* the amount of air actually reaching each seat, or approximately the amount of air exhausted or returned from the seating area of the theater.

A properly arranged withdrawal of air through floor grilles parallel to the sill of each exit door effectively prevents any draft from reaching the nearby seats either in summer or winter. The air withdrawn from the exit door sill grilles will include air which has first served its purpose of heat and moisture removal from the people occupying adjacent seats and any outside air leaking in through the door. Air forced into the lobbies by a separate fan may be return air from the theater, reheated during the winter. This, with the air exhausted through the toilets and projection room, will not total more than the amount of make-up, or outside, air which should be used at any time and for which the plant should be designed.

A plant thus designed will prevent infiltration drafts and will efficiently serve the theater patrons for whose benefit it is presumably designed. Expensively conditioned air will not be forced out of the theater without having come within speaking distance of those in the seats.

Today we think of air conditioning as involving three essential elements—temperature, humidity and air movement. But the point for which these essentials are provided is the point at which the theater patron sits. Thus if the air intended for the patron is otherwise dissipated the patron suffers. And this loss of air, oftimes aggravated by bad distribution of return air outlets, is just what so frequently causes local centers of high temperatures and "dead" or still air.

Temperature differences of as much as 8 F on a single floor level in a cooled theater are not unknown and this temperature difference does not measure the full extent of the difference in comfort because the lack of air movement in the high temperature zones actually makes the discomfort of those seated there greater than that indicated by the temperature reading.

Real Distribution: The air moved by the ventilating system passes through the theater more or less directly from the points of inlet to the points of outlet. The velocity of the incoming current of air will more or less alter this line of passage but this velocity effect is very small about the points of air exit. As the entering air can not be directed towards each seat in the theater, and can not be given just the right velocity to reach each seat, there remains but one way of conducting the air to all portions of the seating areas. This assumes also that the exhaust effect (or pull) is reasonably uniform throughout the entire exhaust side of the system.

Assurance of this result may be had in the correct design of the system by proportioning the volume of air supply and return air for the separate sections of the theater, as indicated in Fig. 1, and so locating air inlets and outlets that the amount of air moved through each section will be in proportion to the number of seats located therein, the return (or exhaust) outlets especially to be generally and uniformly distributed in the

*Consulting Engineer, New York City. Member of Board of Consulting and Contributing Editors.

[2]"Consulting Engineer Surveys Theater Heating and Air Conditioning," HEATING, PIPING AND AIR CONDITIONING, December, 1934, pp. 497-500, and "Theater Air Conditioning," HEATING, PIPING AND AIR CONDITIONING, January, 1935, pp. 14-16.

floor of each section according to the number of seats.

A small surplus of air supply in the ceiling of section *A*, with a corresponding reduction in sections *B* and *C*, is permissible if the return outlets in these sections are

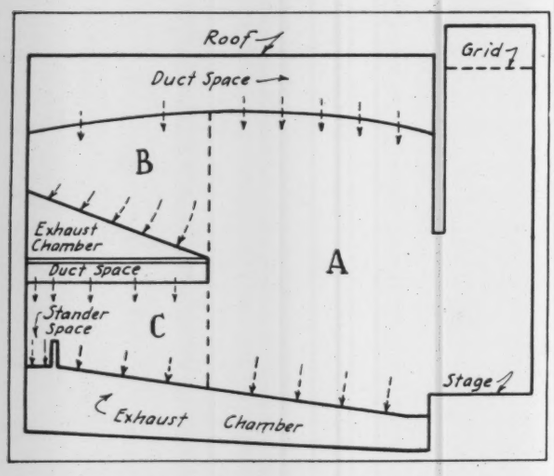


Fig. 1—Air supply to and air returned from the various sections of the theater should be proportioned to the number of seats in each section

correctly proportioned and are generally distributed, because the height of the inlets in section *A* above the floor will allow the air admitted there to easily reach the nearest return of the outlets in sections *B* and *C*. In very large theaters the separate control of the temperature of the incoming air for these three sections is desirable.

A highly theoretical distribution of air might be assured were the main ceiling and the ceiling of the balcony soffit perforated as air screens, the adjacent duct spaces being used as plenum chambers, with the entire floors over the exhaust chambers being grilles upon which the seats were placed. Of course this is highly impractical, being objectionable architecturally and otherwise. The advantages of a certain amount of air turbulence by concentrated air supplies, with a high velocity of the incoming air, would be lost. Nevertheless, the nearer the practical distribution of air inlets and return outlets (and most especially the latter) approach this ideal the better are the results. Invariably are areas of excessively high temperatures and "dead spots" found to be without return (or exhaust) outlets.

There is one exception to this statement concerning high temperature areas—where the air must pass across a considerable number of seats, to reach the return air outlets, as in a balcony where all return outlets are located at the rear (or front) of the balcony, with the air supply at the opposite end of the balcony. In this case the air temperature increases as the air moves over people, often to the discomfort of those about or nearest the return air outlets.

While the most satisfactory air distribution was found where the exhaust chambers in Fig. 1 were extended under the entire area of the seating sections a very fair substitute for the chamber under the entire orchestra floor is found in the use of return air tunnels, if a sufficient number of ample cross-sectional area are carried the entire length of the orchestra floor, preferably in the center of the space between the aisles rather than under the aisles, so that four to five rows of mushrooms can be installed across the width of the tunnel (*i. e.,* under each row of seats). For a uniform movement of air through all of these mushrooms the velocity (or minus pressure) in these return air tunnels must be very low.

An exhaust chamber under the orchestra floor *should not be used for other purposes* and should be a tight chamber.

In the balcony, generally-distributed riser grilles under or back of the seats seem preferable to mushrooms because they offer less difficulty in sweeping the floor, are less apt to become dislocated and less dirt is accumulated therein. Perforated hollow chair legs with metal sleeves connecting to the exhaust chamber are very satisfactory as return air exit openings.

Air supply openings and return air outlets in proportion to the maximum number of people allowed to occupy the "standee" space at the rear of the orchestra floor should be provided directly within this area. A great many complaints are made concerning the ventilation of this space. It is to be remembered that the occupancy here may be very dense and, sometimes, for a lengthy period.

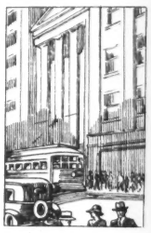
Spring and Fall Operation: There are periods during the spring and fall when neither heating or cooling is required although a 100 per cent supply of air is needed. Therefore the outside fresh air intake opening and connecting ducts should be of a capacity sufficient to supply the full volume of air needed in the theater for proper ventilation without resorting to the use of unconditioned return air.

In one instance, in a large theater having balcony and gallery fully occupied on a very warm day, the dampers at the outside air intake opening were found tightly closed. The operating engineer explained this was necessary to prevent the overloading of his refrigerating machine, and this seemed very probable. In spite of the crowded house the conditions seemed very good and no odor was noticeable. But in some other cases, with a very restricted outside air supply, the conditions were not so good.

Accessibility of Equipment: Accessibility of equipment is very desirable. Fan rooms so located as to involve excessive time and labor to be reached are neglected, and crowded, inaccessible apparatus is not properly maintained and often is not properly operated.

Amount of Cooling: The cooling of a theater frequently is excessive. There are still managers who want 72 F inside when it is 95 F outside. The simple rules generally recommended as a guide to the desirable inside temperature seemed complicated to some of the managers. The suggestion was then offered that the theater temperature be kept at a point half-way between 72 F and the outside temperature, but with never less than 7 F of cooling, except that the inside temperature should at no time be less than 72 F during the summer. But here again the volume of air supply and its distribution enters in, for in those theaters having a small air supply and poor air distribution and air movement, a greater degree of cooling is required. The relative humidity may be governed according to the inside temperature.

Construct and Equip the Building for Economy in Heating and Air Conditioning



THE sun plays an exceedingly important part in the heat-conscious lives of people. Heat from the sun does not directly heat air to any significant extent, but any object which sunlight sees absorbs heat and may transfer this heat to the air which passes around the object. Sun heat is almost as potent in winter as in summer, and can cause over-heating of rooms even on exceedingly cold days.

Exact evaluation of the heat receipt from the sun is difficult, but it is in the neighborhood of 200 Btu per hr per sq ft of dark colored surface, provided that this surface is at right angles to the rays. Sunlight passing

By **Samuel R. Lewis***

through glass may impinge eventually on surfaces inside a room of very much more area than that of the glass itself. Since the sun-exposed area inside a room is constantly being changed, the heat transferred by it to the air is exceedingly difficult to measure, but it safely may be assumed that sunshine through glass will deliver as much as 200 Btu per sq ft of glass opening provided that the sunlight strikes the glass at somewhere near a right angle. This value must be modified, of course, by the amount of light-absorbing smoke or haze in the air outside, since when the direct bright sunlight is interrupted by anything which causes shade, the sunlight heat absorption practically ceases.

I know of no way to take credit for the winter time sunlight heat, by reducing the size of the heating apparatus. On the contrary, the design of the pipes and ducts must be such that when the sun does shine the amount of heat delivered to the sunny side may be reduced without reducing the amount of heat going to the other sides of the building. This volume of heat, however, must be available very quickly for service when the sun passes under a cloud.

Zone temperature control of heating systems achieves remarkable economies largely by allowing the sun to do a share in the heating. The zone control system simply keeps heat out of the sunny rooms and thus prevents the opening of windows, which otherwise would be necessary to get rid of the surplus heat. The savings thus are not in first cost but in operating cost.

When it comes to designing refrigeration plants for cooling rooms, there is a real necessity for evaluating the sunshine heat. In this case the cooling system must be able to care for the normal air-to-air heat input and in addition must have enough standby capacity to balance the sun heat.

Sun heat through walls is of comparatively small importance, because the wall does not receive the light except at a sharp angle and then only during the brightest sunshine hours of any day. If the wall is of any real use as a barrier to heat transfer, the surface will be rid of the sunlight before the heat from the latter will have had time to travel through the wall. As soon as the wall "moves out" of the direct sunlight the heat in the wall leaves the wall most rapidly from its warmer side, the side which has just been heated, and thus the sun heat temperature increase may not be noticeable in the space enclosed by the wall.

The effect of sun heat on roofs is different from that on walls. The roof receives the sunshine at right angles during the brightest sunshine hours and the roof cannot "move out" of the bright light as a wall does. A very large part of the sun heat thus enters the roof and manifests itself within the building.

These observations indicate that walls and roofs which are thick, and which therefore may be resistant to heat transfer or are well-insulated, are the kind which ought to be encouraged for summer air conditioning as well as for winter air conditioning.

Double glass reduces materially the air-to-air heat transfer and permits carrying higher humidities in winter; if the sunlight can shine through it, however, double glass does not materially reduce radiant heat transmission.

A window shade or venetian blind on the inner side of a window may prevent the sunlight from seeing the floor or other surfaces which otherwise it might make very warm, but the shades themselves become heated and they transfer this heat to the air in the room. Interior sunshades can do a great deal of heat transfer work because their area is seen by the sun for almost as long a period as the glass itself is seen. It is not considered wise, therefore, to reduce the designed size of the cooling

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apparatus for any room on the promise that inside shades will be provided or operated.

It has been found by research at the University of Illinois that awnings of the projecting type outside of windows reduce the refrigeration demand for equal cooling while the sun shines to about 80 per cent of what it would have been had the bright sunshine not been shut out. The place to reap the reward for awnings then is in operation rather than by reducing designed capacity.

If there is a neighboring building which keeps the bright sunshine from impinging on the windows, no direct sunlight heat need be considered. However there is always doubt whether the adjacent building will remain to act as a shade-producer, and if a refrigerating plant is installed without capacity to compensate for sunshine the plant may be too small to give the expected results after the shade-producer is removed. It appears, therefore, a wise practice to provide cooling capacity in the original design for the sunlight heat which may be received on the east, or south, or west walls and glass, whichever side has the greatest exposure at the time when the sun heat is the greatest.

The design capacity of the cooling system might be based on whichever of these is the greatest, disregarding the heat from the other two orientations and disregarding shade from awnings or from other buildings. Then if shade is available, or if awnings are provided and are maintained and operated, a substantial saving in operating cost can be realized.

Much can be done to promote the success and economy of a winter or summer air conditioning system in the design and equipping of the building itself. For example, consumption of coal per unit of heating area in buildings (as proved during the war-time fuel administration) was no greater in the chilly North than in the balmy South, for the tendency is to construct buildings in the North which are more resistant to heat transfer than those in the South. With year 'round air conditioning growing in importance, any economies which can be secured by more suitable building construction become all the more attractive. The author suggests in this brief summary what may be done to promote heating and cooling economy through providing certain features in the construction of the building. Heat from the sun is one of the important considerations, as is infiltration.

Infiltration a Factor

When heating and humidifying or when cooling and dehumidifying, it is necessary to provide conditioning for the air which leaks past the barriers and for the air which is provided to dilute odors and other things which may defile the air of enclosures.

In winter the uncontrollable infiltration of air from outside may amount to a considerable volume. Tests by the University of Wisconsin indicate that all the air forced into a school room, up to as much as six changes of the room contents per hour, will leak out of that room while the vent flues are closed tightly, without any substantial increase in the air pressure maintained in the room. Savings in fuel due to the application of metal weatherstrips on leaky windows in winter thus may be a very real saving.

In summer there is evidence that uncontrollable infiltration becomes very much less than in winter, due probably to the reduced difference in temperature between indoors and outdoors. (In winter 70 F to 80 F; in summer 10 F to 15 F.) It is the author's experience that ventilating systems which provide acceptable dilution of odors in winter, when equipped with refrigeration and when operated in other particulars just as in winter, are far from acceptable in summer, as odors almost invariably are complained about. Comfort cooling systems require a definite air movement for diffusion purposes, and the volume of the air moved, generally, should be made up of not less than ⅓ new air, in order to dilute odors.

It is possible that some day an apparatus which will remove odors from air may be discovered. Ozone helps, but ozone has not met with general acceptance for the purpose. The Harvard University School of Public Health actively is pursuing this scent.

There is nothing particularly difficult about preparing any building for complete air conditioning. There should be attention to making the roof a good heat barrier. This can be done by providing an attic space[1] and by insulating the roof so that this space above the top story ceiling will not be much warmer or colder than the room temperature close to the ceiling. Roofs of a type which will reflect sunshine rather than absorb it are very helpful. Covering skylights with whitewash which disappears by the late autumn days when more light is needed has reduced the cost of refrigeration.[2]

White enameled brick walls and white tile paving for roofs make for cooler buildings in summer than do black walls and roofs.

[1]By using a vented roof space on an industrial laboratory building heat gain through the roof was reduced over one-half and the refrigeration capacity required for summer air conditioning was cut down to economic advantage. See HEATING, PIPING AND AIR CONDITIONING, September, 1932, p. 595.

[2]This is done at the Toledo Museum of Art, for instance, as described in an article in the September, 1931, issue of HEATING, PIPING AND AIR CONDITIONING, pp. 910-915.

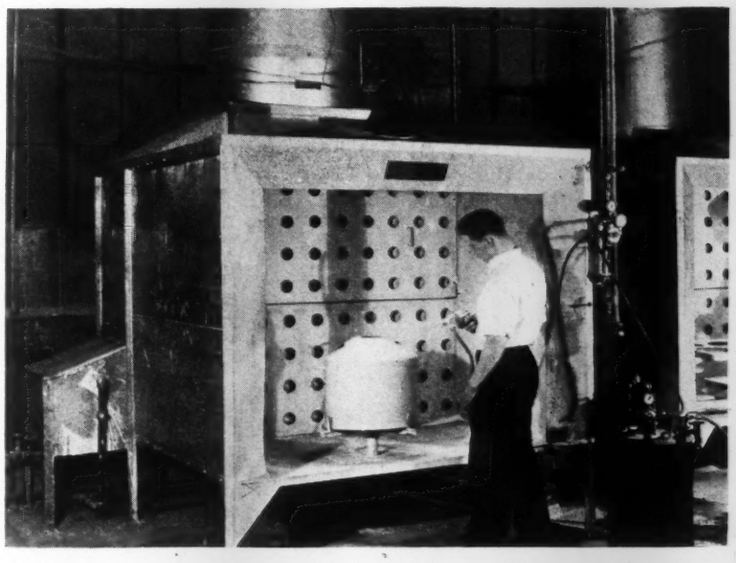


Fig. 1—Front view of spray booth at the Edison General Electric Appliance Co. plant showing the baffle plates (with holes) that reclaim the greatest portion of the sprayed material; that which passes through the baffle plates with the exhaust air is reclaimed by a two-stage water spray. The exhaust duct is seen at the top

Enamel Shop Prevents Contamination of Air, Fouling of Ducts, Reclaims Enamel

UNLIKE complete air conditioning for comfort (which as defined by the *American Society of Heating and Ventilating Engineers* involves the simultaneous control of all or at least the first three of those factors affecting both the physical and chemical conditions of the atmosphere within a structure—temperature, humidity, air motion, distribution, dust, bacteria, odors, toxic gases, ionization), industrial air conditioning may not incorrectly be thought of as the proper treatment of the air to meet the particular requirements of the process under consideration. Thus, relative humidity is an important factor in the manufacturing and processing of certain hygroscopic materials,—for example, textiles. Because the normal relative humidity in textile factories is nearly always lower than that desired, air conditioning in this industry may be thought of as humidification. On the other hand, many industries require a definite and unvaried humidity so that at times the amount of moisture in the atmosphere must be increased and at other times decreased—air conditioning in such plants involves dehumidification as well as humidification. In the broad sense, air conditioning in certain plants means dust control, where this is the only "atmospheric problem."

Air conditioning in industry leads to many advantages. Frequently it is essential to carrying on the particular process at all. In others it means a better product manufactured more economically than would otherwise be possible. It may increase the efficiency of employees, save material and time, prevent shut-downs, cut operating cost.

In an enamel shop the atmospheric or air conditioning problem is to prevent contamination of the air, with reclamation of the enamel sprayed an additional dividend to be credited to the air handling and treating equipment. A system which accomplishes these objectives was recently installed at the plant of the Edison General Electric Appliance Company, Chicago. The installation involves ten-spray booths (four single and three double conveyor booths) in which the product is sprayed with enamel, sixteen dusting tables where the rimming operations are performed, and the associated exhaust duct system, fan, etc.

Fig. 1 is a close-up of one of the spray booths. Air is pulled into the booth and through the perforated distributing plates at the back of the working section of the booth, the purpose of the distributing plates being to provide a uniform draft of air over the entire working section of the booth. The fume-laden air is then carried downward where it is washed by a bank of low pressure nozzles of non-clogging design, then passes upward through a second bank of nozzles, through a set of eliminator plates to remove the entrained moisture, and then into the exhaust duct. A pump recirculates the water from a catch basin through the spray nozzles, and a make-up chamber with a float switch lets in additional water as required to compensate for that evaporated.

There are a number of reasons for "conditioning" the air from such a spray booth before it is exhausted to the outdoor atmosphere. Among these, is the fact that the new material that has made its appearance in the finishing field within the past year or so (known broadly as "synthetic enamel") dries much more slowly than the lacquer formerly used. This synthetic enamel, if permitted to go into the exhaust duct, will adhere to the exhaust fan blades, in the inside of the exhaust pipe and continue to collect to such an extent that it will

Photos courtesy Binks Manufacturing Company, Chicago.

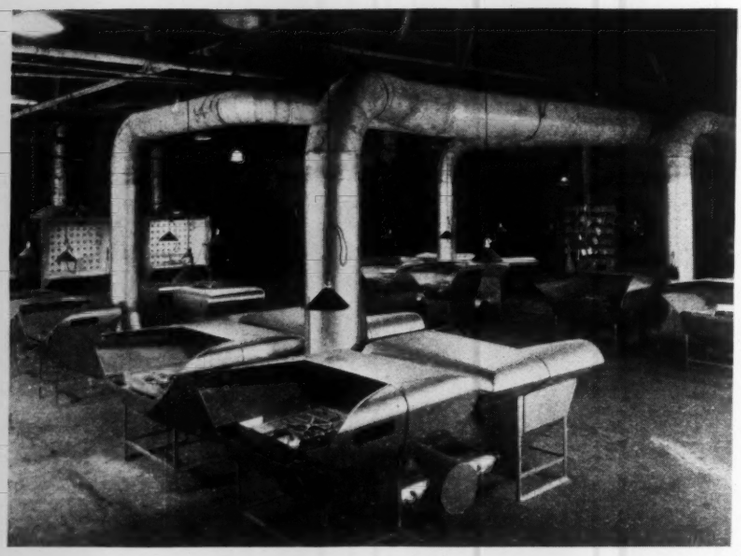


Fig. 2—After the product has been sprayed it is conveyed to these dusting tables where the rimming operations are performed by wire brushes. The suction system draws the dusty air through the ducts to prevent contamination of the plant air

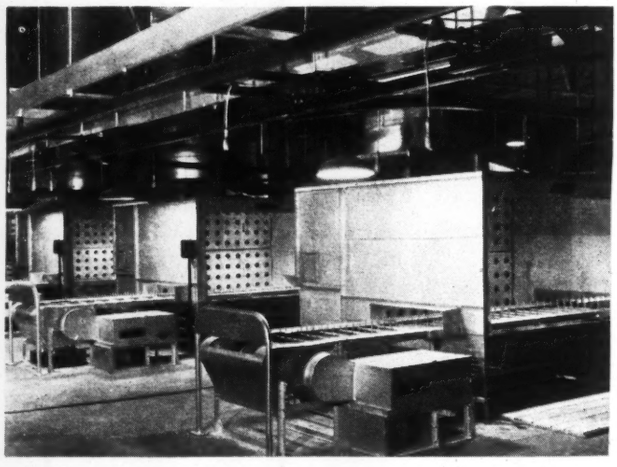
reduce the efficiency of the fan and duct system. Preventing contamination of the air both in and around the plant is also an important consideration.

In addition to preventing contamination of the air and the fouling of the exhaust ducts and fan, this system makes a very worthwhile saving in reclaiming the enamel which is sprayed—97 to 98 per cent of that which is sprayed into the booth being reclaimed, according to J. F. Roche, Jr., engineer, Edison General Electric Appliance Company, who has estimated that in an average shop a saving of over $17,000 annually is thus possible. This estimation is arrived at as follows:

The average enamel shop runs for approximately 16 hours a day, 5 days a week. During the period of a week's production, 9000 lb of enamel are sprayed; of this 9000 lb, 4000 lb or 44.5 per cent are applied to the wares sprayed, and 180 lb or 2 per cent are lost up the stack. The remaining 4820 lb or 53.5 per cent are reclaimed by the spray booths.

Reclaimed enamel is worth approximately 8 cents per lb, which should make the saving involved over a week's run amount to approximately $385.60. Figuring the average production year at 48 weeks, the yearly saving on material would amount to $17,508.80.

Fig. 3—Battery of three double booth conveyor spraying machines



Air Conditioning Installations in Two More Cities Reported

SUPPLEMENTING the survey[1] published last month of the number, tonnage, and horsepower of 1934 air conditioning installations as compared with previous years, the figures for Dallas, Texas, and Newark, N. J., are presented here. Data for these cities were not available in time to include in the survey.

Newark—There were 15 installations previous to 1934, the total refrigeration tonnage amounting to 1,164 and the total horsepower being 1,513. During 1934, 8 jobs were installed with a total tonnage of 96 and a total horsepower of 124. Thus, the number of installations increased 53 per cent, the refrigeration tonnage 8 per cent, and the horsepower 8 per cent.

Dallas—Of the 44 installations with mechanical refrigeration now in service (exclusive of residential jobs) which total 1,806 tons and 3,327 horsepower, 16 were installed during 1934. These 16 jobs represent 114 tons and 136 hp. Two additions to existing systems made in 1934 also added to the tonnage and hp for air conditioning. The Baker hotel added a 100 ton refrigerating machine which was tied into the existing refrigeration system, unit air conditioners totalling approximately 115 tons were installed for various public rooms, and the net additional horsepower added was 203½. The Neiman-Marcus store added two units of 15 tons capacity with 4½ hp in fans; these conditioners are supplied from the existing refrigerating system.

Nineteen of the 44 systems are of the central type and 25 are unit jobs. Of the sixteen 1934 jobs, 5 are central and 11 unit.

Of the 31 evaporative cooling type of systems totalling 156 pump hp and 360½ fan hp, one was made in 1934 (5 pump hp and 5 fan hp). Nineteen of these installations are in theaters, and the balance in restaurants, hotels, a church, etc. Of the 24 residential installations totalling 33½ tons and 47½ hp, 15 (representing 20¾ tons and 28¼ hp) went into service in 1934. All of the residential jobs are the unit type except two, one of which was installed in 1934.

The above data were obtained through the electrical utilities in each of these cities, whose cooperation is gratefully acknowledged.

[1] "Total Installed Air Conditioning Tonnage Increased by 21% in 1934", Heating, Piping and Air Conditioning, January, 1935, pp. 1-4.

Methods of

USING WASTE HEAT

from Diesels

Frequently it is found that internal combustion engines are the most economical prime movers for generation of electricity, where the cost of labor for operating small and medium size plants is a large factor in the total cost of power generated. . . . There are available (in addition to the larger non-automatic types) in several types of completely automatic units which require no regular attendants, may be operated continuously on varying loads of any description with nothing more than periodic inspection and servicing.

Much study and research has been spent in improving the economy of operation of diesels, especially along the lines of utilization of the waste heat from these units. This waste heat—consisting primarily of that ordinarily carried off by the jacket water used for cooling the cylinders and bearings, and by the exhaust gases—may be used by the plant or building for a number of purposes as outlined here.

NOTWITHSTANDING the fact that the position of the diesel engine as a machine for converting heat energy into mechanical work is high, there remains a very considerable saving to be made by the reclamation of the waste heat, which consists primarily of that ordinarily carried off by the jacket water used for cooling the cylinders and bearings and by the exhaust gases. In the larger plants this waste heat can be used for generating steam for space heating, or for driving auxiliary turbines. It is sometimes used for preheating the oil and air used for combustion in the engines; also for distilling water for use in jackets, and for sale. Aboard ship the entire fresh water supply may be supplied from this source. In smaller plants it is used for heating water for domestic use or for other heating purposes. This heat may also be used for drying and other industrial processes.

By **Perry West**
Consulting Engineer, Newark, N. J.

Available Waste Heat

The jacket water amounts to about 5 gallons per hp-hr or 7.5 gallons per kw-hr delivered at the switchboard. Assuming the entering temperature at 70 F, the leaving temperature of the jacket water is about 135 F, at full load, reducing to about 100 F at half load, averaging about 120 F.

The quantity of waste heat available in the exhaust gases depends upon the initial temperatures of the gases and the temperature to which these gases are cooled. This initial temperature ranges from 550 to 750 F at full load, reducing to from 350 to 400 F at ¼ load. The lowest practical temperature to which these gases can be cooled is about 300 F, as below this point condensation is likely to cause excessive corrosion from dilute sulphuric acid.

The temperature of the medium being heated also acts to determine the temperature of the gases leaving the heater as it is not generally economical to cool lower than 50 F above the temperature of this medium. If (for example) water is being heated to a final temperature of 175 F it is not economical to cool the gases below 225 F and better still to stop at 300 F because of corrosion. If steam is being generated at 100 lb gage, corresponding to a temperature of about 338 F, it is not economical to cool the gases much below 400 F.

Diesel engines discharge from 12 to 20 lb of gas per hp-hr and inasmuch as the specific heat of these gases is about 0.25 the heat to be reclaimed amounts to from 3 to 5 Btu per hp-hr per degree drop in temperature of the gases. This, with an average initial temperature of 600 F amounts to from 900 to 1500 Btu per hp-hr for heating water and from 600 to 1000 Btu per hp-hr for generating steam at 100 lb gage.

Savings to Be Effected

Inasmuch as the diesel engine is about 33 per cent efficient and about 45 per cent of the original heat can be reclaimed in the jacket water and exhaust when heating water to 175 F, it is readily seen that the heat efficiency of the combination is more than twice that of the engine alone.

In the generation of steam the saving is only about 8 per cent so that the overall efficiency is increased only about 25 per cent. The saving to be effected by heating the air and oil of combustion is about 10 per cent.

In addition to the saving in heat there is a further sav-

ing in water where the jacket water is used for feeding the domestic hot water system.

Waste Gas Heaters and Boilers

These are primarily of three principal types—boilers for steam generation, water or oil heaters and air heaters. These are generally constructed so as to have the hot gases from the engine pass through a chamber within which the medium to be heated is also passed through tubes (or through passages in other forms of heating surface) so arranged as to keep the two mediums separated, but at the same time allow the most rapid and efficient transfer of heat.

These are also arranged to constitute effective mufflers for deadening the pulsations and noise from the exhaust so that the addition of a separate muffler is not necessary.

They are also constructed so as to be operable dry, or without the water or other medium to be heated, for the double purpose of making it possible to burn the oily soot from the heating surfaces and so that they may have this medium by-passed for inspection and repairs to the apparatus without stopping the flow of gases through the heater or boiler. Such an arrangement also makes them foolproof in case they accidently run dry. They must be rugged and capable of withstanding all kinds of abuse and neglect. The heating surfaces must be readily cleanable and provided with soot blowers or other proper means of cleaning when necessary. The materials of construction must be highly non-corrosive and arranged to withstand all kinds of expansion strains without causing leaks in either the gas or liquid chambers.

Boilers may be of the horizontal tubular type, the vertical tubular type, or of the cellular type. The gases may pass directly through the boiler, or they may enter and leave at the same end. In either case the tubes are staggered to break up the gas streams and not only bring them into immediate contact with all of the heating surface, but also to iron out pulsations and produce a satisfactory muffler effect. These boilers must be equipped with the usual trimmings such as steam and water gages, safety valves, feed valves and blow-off connections.

Because the heat supply to these boilers is constant so long as the engines are running and at rates depending upon the load on the engines, regardless of the demand for steam from the boilers, the safety valves should be ample and arranged to discharge any surplus steam to the atmosphere without causing a dangerous or troublesome hazard. The water supply should be certain and preferably automatic, with automatic high and low water alarms. They should be constructed to withstand operating dry up to 1000 F, which is about the limit of gas temperatures so long as the jacket cooling system on the engine is operative.

Any one of the above described types of boilers may be used as heaters for oil, water or air, but of course the trimmings must be changed to suit. For water or air heaters a pressure gage is used in place of the steam gage, the water gage is dispensed with, and relief valves properly piped to sewer with open inspection connection often replace the safety valves. The water or oil feed is piped to the end where the coolest gases are leaving, so as to produce a counter-flow and instead of the steam connection a water or oil outlet is provided at the end where the hot gases are entering. A thermometer should be placed in the inlet and outlet connections and a three way valve or a three valve full size bypass for the gas should be installed around the apparatus. The fluid should also have a similar valved bypass arrangement. Provisions should be made for preventing overheating of the water or oil as will be discussed later. Blow-off and wash-out facilities should be provided the same as for boilers.

Another type of heater and one most generally used consists of a chamber through which the gases pass, filled with tubes passing through the chamber from an inlet box to an outlet box for the water or oil. This enters one of these boxes, passes through the tubes to

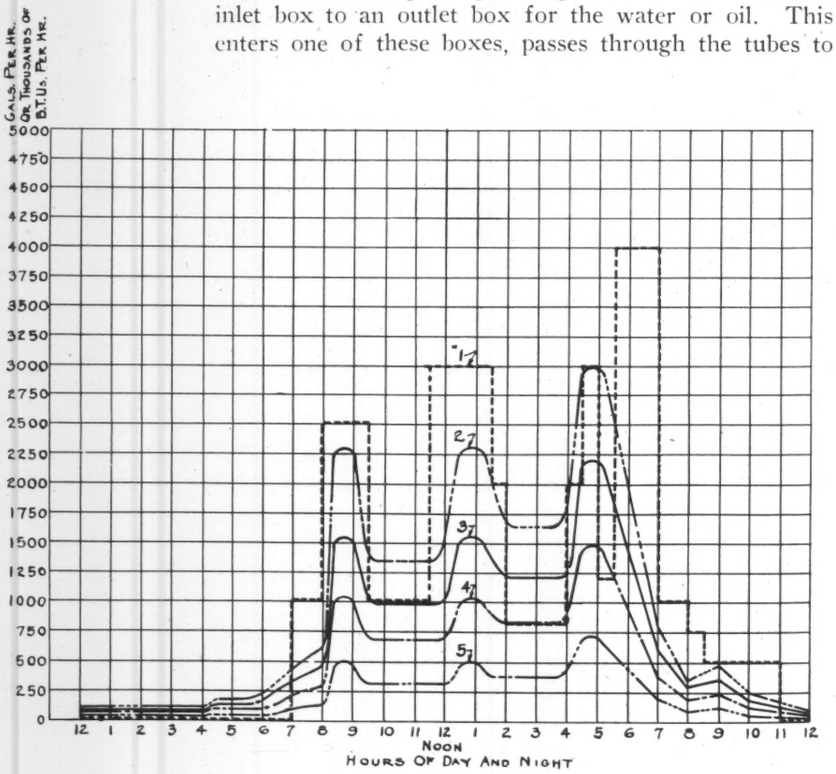


Fig. 1—Hot water requirements and the coincident usable waste heat in jacket water and exhaust gases from diesel engine driven electric generators in an office building

Curve 1 shows domestic hot water required in gph and Btu per hr for heating same.
Curve 2 shows quantity of jacket water in gph.
Curve 3 shows the total heat available in Btu per hr in jacket water and exhaust gases.
Curve 4 shows the heat available in Btu per hr in the jacket water.
Curve 5 shows the heat available in Btu per hr in exhaust gases.

the other and is discharged from thence to its point of use.

The inlet and outlet boxes may be provided with partitions so as to force the liquid to travel back and forth several times in a multi-pass fashion instead of single pass. The inlet for the liquid may be at the top and the outlet at the bottom, so as to get a counter-flow arrangement if desired. The tube sheets and the liquid boxes are of cast iron and the tubes of arsenated copper or other corrosive resisting material. Such a heater is arranged with hinged clean-out doors, preferably on both sides, exposing the entire bank of tubes for cleaning by compressed air, steam or brushing.

One disadvantage is that the engine must be shut down or a three valved full size bypass must be provided for the gases during cleaning. The rate of heat transfer in heaters may be taken at from 6 to 8 for water and from 3 to 4 for oil in Btu per sq ft per hr per degree difference in temperature between the gases and the medium being heated, but this decreases very rapidly as the surfaces become coated with soot. Inasmuch as the temperature of the gases is decreasing and the temperature of the liquid being heated is rising during their passage through the heater the logarithmic mean temperature difference must be used. The fundamental formulas for this are as follows:

$$\textit{For parallel flow: } D = \frac{(T_1 - t_1) - (T_2 - t_2)}{\text{Log}_e \frac{T_1 - t_1}{T_2 - t_2}}$$

$$\textit{For counter flow: } D = \frac{(T_1 - t_2) - (T_2 - t_1)}{\text{Log}_e \frac{T_1 - t_2}{T_2 - t_1}}$$

Where

D=Logarithmic temperature difference, F
T_1=temperature of entering gases, F
T_2=temperature of leaving gases, F
t_1=temperature of entering liquid, F
t_2=temperature of leaving liquid, F.

An important factor with all boilers and heaters is that they be so constructed as to offer as little resistance to the flow of gases as possible, in order not to create an objectionable back pressure on the engine. At the same time the static pressure and velocity through these must be sufficient to cause proper contact and complete sweeping of all heating surfaces. From 2 to 3 in. of water pressure per sq in. is the usual practice.

The Heat Balance

An average consumption of 0.636 lb of oil per kw-hr delivered to the switchboard, corresponding to 0.424 lb of oil per indicated hp-hr, would give the following results:

Total heat liberated in the engine cylinders per indicated horsepower =18000 × 0.424	7632 Btu	
Heat converted into work	2,545 Btu	= 33.3%
Heat carried off by jacket water	2,500 Btu	= 32.8%
Heat carried off by exhaust gases	2,437 Btu	= 31.9%
Heat carried off by radiation	150 Btu	= 2.0%
	7,632	100.0%

Of the heat carried off in jacket water practically all of this can be conserved if the total quantity of this water can be used.

With jacket water entering at 70 F and leaving at 135 F, the total quantity required is about 5 gallons per hp-hr or about 7.5 gallons per kw-hr delivered to the switchboard.

Of the heat in the exhaust gases about ½ can be conserved when heating water from 60 to 175 F and about 1/3 when generating steam at 100 lb gage, provided in each case all of this heat can be used when and as liberated.

The final amount of heat to be saved will of course depend upon how the load curve for the engines and the consequent curve representing the rate of liberation of heat at different times fits into the curve represent-

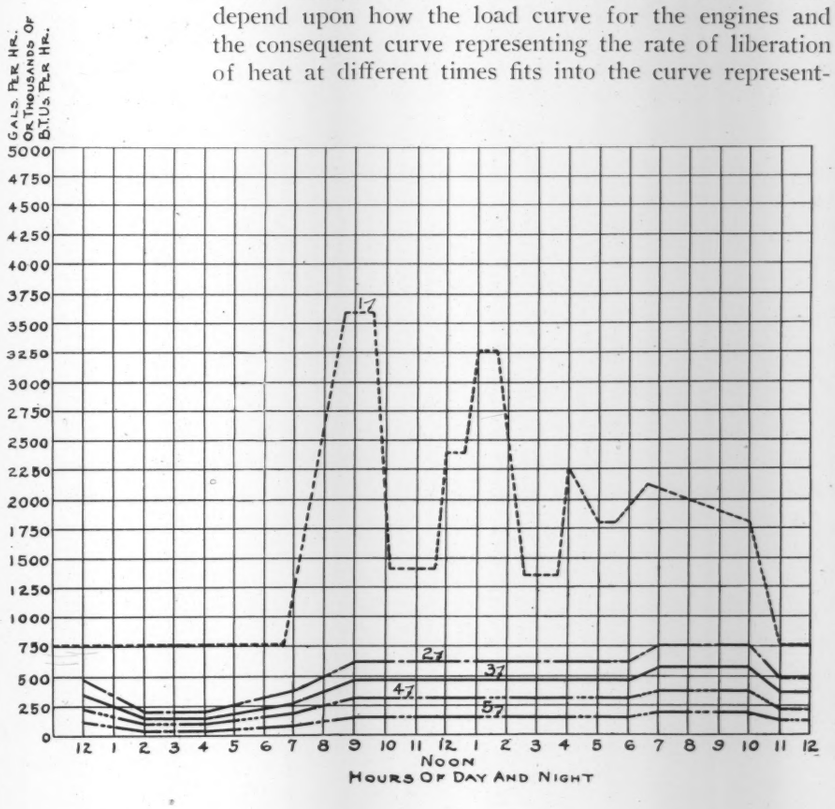


Fig. 2—Hot water requirements and the coincident usable waste heat in jacket water and exhaust gases from diesel engine driven electric generators in a hotel

Curve 1 shows domestic hot water required in gph and Btu per hr for heating same.
Curve 2 shows quantity of jacket water in gph.
Curve 3 shows the total heat available in Btu per hr in jacket water and exhaust gases.
Curve 4 shows the heat available in Btu per hr in the jacket water.
Curve 5 shows the heat available in Btu per hr in exhaust gases.

ing the demand for the use of this heat plotted against corresponding periods of time. Both of these variables usually have wide ranges of variations and must be plotted and compared to get the solution. The electric load for buildings for instance, varies widely during the various hours of day and night and for week ends, holidays and other special days. The demand for hot water for buildings, if this is what the heat is to be used for, has similar variations which for different classes of buildings bear different relations to the electric load. The liberation of heat from diesel engines will vary approximately in proportion to the power loads, with slight corrections for the oil consumption at partial loads as compared with full load which ranges from 0.6 to 0.4 lb per kw-hr.

These variations may be somewhat balanced by water storage capacities or by using some of the surplus heat for augmenting other heat requirements such as building heating, etc., during periods of excess.

The heat required to preheat the air for the engines may be taken at from 600 to 800 Btu and for heating the oil for combustion at from 50 to 75 Btu per indicated hp-hr. If waste heat is used for these purposes it must be deducted from the heat in the exhaust gases. Caution must be used in this, however, as overheating the oil or air and variations in their temperatures cause trouble.

The curves given here are intended to show typical conditions as to hot water requirements, waste heat usable for heating this water and the waste heat available from diesel engine generating plants for office buildings, hotels and apartments. It should be noted that practically 50 per cent of the water for office buildings, about 25 per cent of the water for a hotel and practically 25 per cent of the water for apartments can be heated with this waste heat, where diesel engines are used for generating all the electric light and power in these buildings.

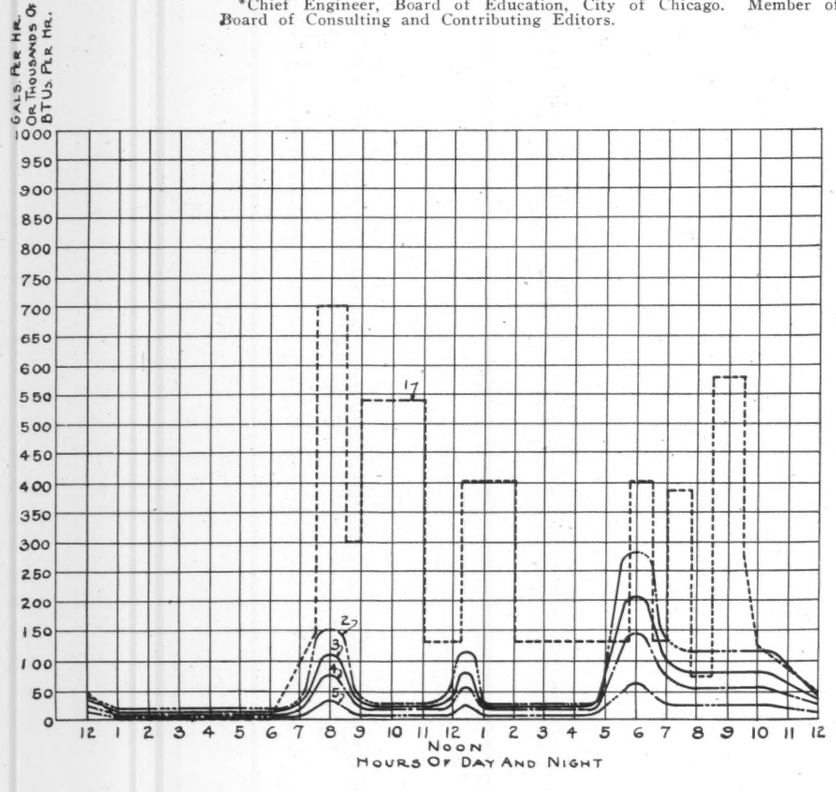


Fig. 3—Hot water requirements and the coincident usable waste heat in jacket water and exhaust gases from diesel engine driven electric generators in an apartment

Curve 1 shows domestic hot water required in gph and Btu per hr for heating same.
Curve 2 shows quantity of jacket water in gph.
Curve 3 shows the total heat available in Btu per hr in jacket water and exhaust gases.
Curve 4 shows the heat available in Btu per hr in the jacket water.
Curve 5 shows the heat available in Btu per hr in exhaust gases.

Modernize Buildings for Health and Comfort as well as Economy

IN buildings designed to house humans, modernization should be considered primarily from the standpoint of the comfort and health of the occupants. Where humans are involved, health and comfort should take precedence over so-called economies, but if a modernization program will provide all three, health—comfort and economy—its value cannot be disputed.

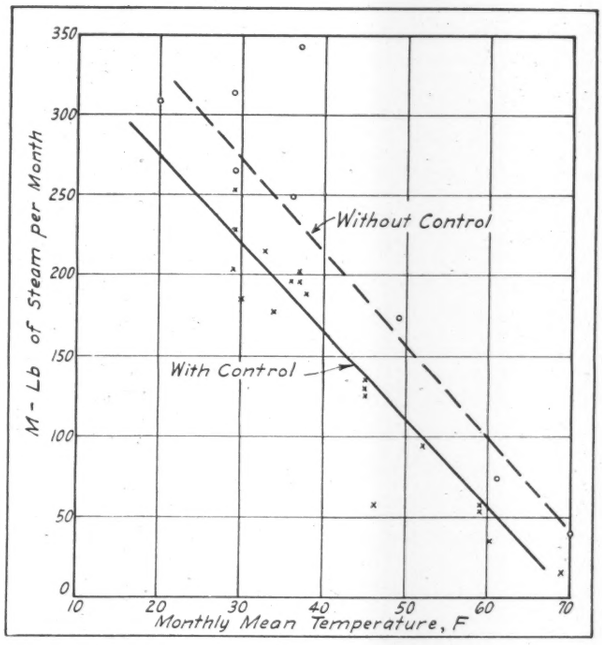
Complete modernization of a building should take into consideration the preservation of the materials exposed to the elements. It should consider the permanent sealing up of all openings about the windows and through the walls that permit excessive aeration of the building with resultant excessive fouling of interiors, excessive demands on the heating and cooling equipment and excessive discomfort for the occupants due to dirty, drafty, uncontrollable indoor conditions.

The idea of modernization should be applied to the means of providing proper atmospheric conditions on the inside of the building, proper lighting facilities to provide a light intensity and distribution that conforms with modern lighting standards, and plumbing facilities so adequate sanitation may be maintained.

Provide for Summer Comfort

If a building is to be made truly modern, means must be provided to maintain inside comfort through the hot summer months as well as in the cold winter months. The market affords equipment that will maintain a comfortable and healthful indoor weather condition both as to temperature and relative humidity the year 'round.—John Howatt.*

*Chief Engineer, Board of Education, City of Chicago. Member of Board of Consulting and Contributing Editors.



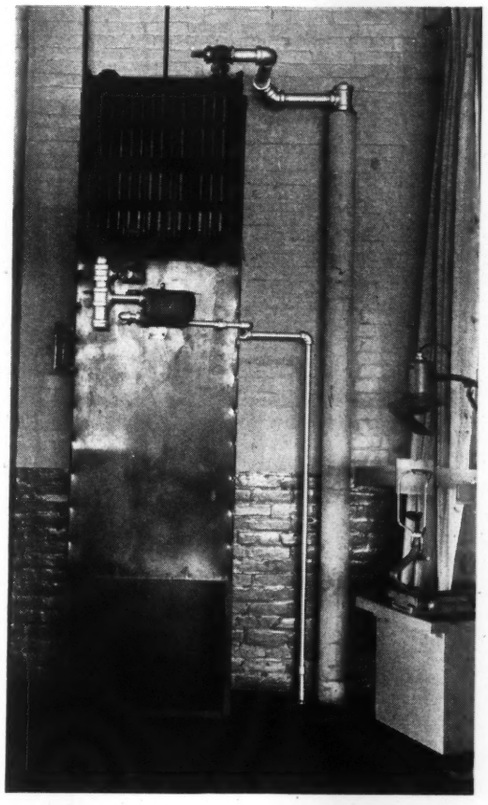
Consumption of steam for heating may be reduced by the installation of automatic control equipment. This chart indicates what was accomplished in a specific case

DIVIDENDS from the PLANT HEATING SYSTEM

POTENTIAL savings in the pounds of steam required for plant heating, maintenance and operation charges are a real source of dividends. To the engineer, economies in heating show up as pounds of steam saved—but to the management, greater efficiency in plant heating means cash in the bank.

That the possibilities for savings are there has been proved by a great number of actual examples, is being proved by more plants every day. To bring these possibilities to light, convert them into cash, the first step is a survey of the complete heating system, either by the plant engineer or a qualified consulting engineer. In many instances the plant engineer realizes already just what should be done to promote the efficiency of his heating system, needs only to realize the importance of investing in the needed work. In other cases, he must first locate the possibilities, and decide what to do to take advantage of them.

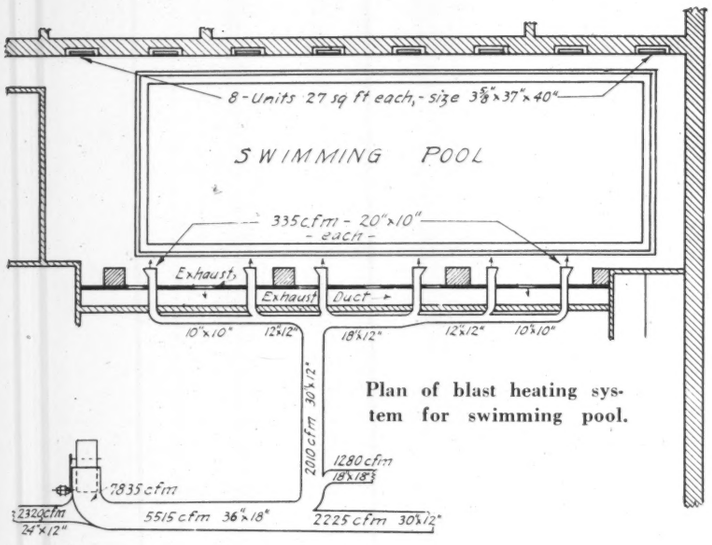
Pounds of steam saved and reduced operating costs are not the only dividends that can be had through well-planned modernization of plant heating systems. Working conditions can be bettered, employee efficiency promoted, the product protected—all of which are obviously worth real money.



Above—Despite the extensive changes made by Bausch & Lomb in modernizing plant heating, the entire cost of the change-over will be paid for by steam savings in less than four years, after which operating costs for heating will be reduced by 45 per cent; in addition, working conditions have been improved. Included in the changes was the installation of 116 unit heaters, one of which is illustrated. Modern unit heaters have many applications in promoting effective plant heating with economy. . . . At right —The investment for these stokers is practically paid off every year in the savings they make

Blast Heating System for a Swimming Pool

By C. C. Hermann*



Plan of blast heating system for swimming pool.

HEATING and ventilating of indoor swimming pools is a matter of considerable importance and well worth some study. Fresh air properly heated and tempered is of prime importance as well as efficient circulation of the air within the room. It is not claimed that the Waterloo (Iowa) Y. M. C. A. has a swimming pool room which is the acme of perfection; however, it is thought that the atmospheric conditions within this room are better than generally found and therefore it may be classed above the average.

The sketch is a plan view of the pool heating system, which consists of sheet metal ducts connecting with a blast system in the basement of the building. This system consists of four stacks of 72 in., 9 section blast heaters and the air movement is produced by a full housed up-discharge fan, 8,580 cfm at 7/8 in. W. G. static pressure, 324 rpm, driven by a 2 hp 220 volt motor driving through a V-belt drive. This system supplies warm air for the health club rooms and other basemem rooms in addition to the swimming pool room.

The swimming pool duct of the system is provided with six outlets each of which is 20 × 10 in. in size and is capable of discharging 335 cfm—a total of 2,010 cfm. The total volume of the swimming pool room is 35,875 cu ft; the air change therefore is once every 18 minutes. The air is removed from the room by means of a concrete duct located beneath the seats at one side of the pool and supplied with six damper equipped openings 18 × 8 in. capable of removing 200 cfm per outlet. This concrete duct is connected to the main duct by a 12 × 18 in. copper duct. The exhaust fan of 7,180 cfm capacity is located in the pent house at the top of the building and handles other exhaust air besides the swimming pool room.

The exposed wall of the swimming pool room contains eight windows of air seal construction. Below each window there is provided concealed copper radiation 3⅝ in. thick and 37 × 40 in. set in recesses in the wall and provided with cast grilles top and bottom. These radiation units have sufficient capacity to handle the wall heat loss and keep the wall dry as well as prevent frosting of the windows in the cold winter months.

It is observed that all heated air is admitted to the room near the ceiling and the exhaust is near the water surface. This is of considerable assistance in maintaining a comfortable temperature and humidity in the room.

*Mechanical Engineer, Waterloo, Ia.

Temperature and Humidity Requirements for Air Conditioning in Philippines

A NUMBER of noteworthy installations of air conditioning systems have been made in the Philippines, according to Trade Commissioner C. Grant Isaacs of Manila in a recent report to the machinery division of the bureau of foreign and domestic commerce. These include two manufacturing plants, the etching room of one of the leading publishers, two of the larger motion picture theaters with another under construction, the operating rooms of two Manila hospitals, several private offices, two passenger coaches on the Manila Railway and installations in two or three private houses.

It is the opinion of one of the leading engineering firms there that the majority of air conditioning equipment manufactured in the United States must be adapted to the requirements prevailing in the local tropical climate, which in many respects is not very different from that prevailing in New Orleans, La., says the report. Care should be exerted in accepting "States" designs and so-called "rule of thumb" instructions. In the tropical climate of the Philippines, dehumidification is regarded as the most important problem,—temperature (sensible) as secondary.

One of the earliest firms engaged in the installation of air conditioning equipment in the Philippines recommends effective temperatures ranging from 78 F maximum to 72 F minimum, relative humidities from 70 to 45 per cent. The effective temperature considered best for majority of people, native and foreign, is approximately 74 F, 45 to 60 per cent relative humidity or roughly,—78 F Dry Bulb @ 60 per cent relative humidity; 80 F Dry Bulb @ 50 per cent relative humidity; 81 F Dry Bulb @ 45 per cent relative humidity.

The same firm recommends the temperatures and humidities as indicated in the following table for office air conditioning installations in the Philippines:

OUTDOOR CONDITIONS				INDOOR CONDITIONS			
D.B.	R.H.	Gr/lb	E.T.	D.B.	R.H.	E.T.	Gr/lb
94°	52%	128	84.6	84°	47%	76.7	85
92°	57%	132	84.1	83°	48%	76.3	85
90°	63%	135	83.3	82°	50%	75.7	85
87°	71%	141	82.2	81°	52%	75.0	85
84°	82%	146	81.2	80°	54%	74.5	85
81°	92%	148	80.0	79°	56%	74.0	85

D.B.—Dry bulb temperature, degrees Fahrenheit.
R.H.—Relative humidity, per cent.
Gr/lb—Grains moisture per lb of dry air.
E.T.—Effective temperature.
Max. difference, D.B., regardless of outside Temp., 10 F.

Heating · Piping
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1895

American Society of Heating and Ventilating Engineers

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FEBRUARY 1935

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President, M. F. RATHER
2142 East 19th St.
Secretary, E. J. VERMERE
2125 Wyandotte Ave.

CINCINNATI
Headquarters, Cincinnati, O.
Meets: Second Tuesday in Month
President, G. B. HOULISTON
704 Race St.
Secretary, I. B. HELBURN
610 Chamber of Commerce Bldg.

ILLINOIS
Headquarters, Chicago
Meets: Second Monday in Month
President, R. E. HATTIS
180 N. Michigan Ave.
Secretary, L. S. RIES
5614 Blackstone Ave.

KANSAS CITY
Headquarters, Kansas City, Mo.
Meets: Second Monday in Month
President, L. A. STEPHENSON
409 East 13th St.
Secretary, L. R. CHASE
217 Dwight Bldg.

MASSACHUSETTS
Headquarters, Boston
Meets: Second Monday in Month
President, R. S. FRANKLIN
38 Chauncy St.
Secretary, W. A. MCPHERSON
86 Dwinnell St.
West Roxbury, Mass.

MICHIGAN
Headquarters, Detroit
Meets: First Monday after the 10th of the Month
President, G. D. WINANS
2000 Second Ave.
Secretary, W. F. ARNOLDY
2847 Grand River Ave.

WESTERN MICHIGAN
Headquarters, Grand Rapids
Meets: Second Monday in Month
President, S. H. DOWNS,
211 Creston Ave.,
Kalamazoo, Mich.
Secretary, W. G. SCHLICHTING,
1417 W. Lovell St.
Kalamazoo, Mich.

MINNESOTA
Headquarters, Minneapolis
Meets: Second Monday in Month
President, C. E. LEWIS
829 Second Ave. S.
Secretary, R. E. BACKSTROM
543 So. Snelling Ave., St. Paul, Minn.

NEW YORK
Headquarters, New York
Meets: Third Monday in Month
President, H. W. Fiedler
489 Fifth Ave.
Secretary, T. W. REYNOLDS
100 Pinecrest Drive,
Hastings-on-Hudson, N. Y.

WESTERN NEW YORK
Headquarters, Buffalo
Meets: Second Monday in Month
President, W. E. VOISINET
250 Delaware Ave.
Secretary, J. J. LANDERS
303 Crosby Bldg.

ONTARIO
Headquarters, Toronto, Can.
Meets: First Monday Every Other Month
President, W. R. BLACKHALL
332 Waverley Rd.
Secretary, H. R. ROTH
1104 Bay St.

PACIFIC NORTHWEST
Headquarters, Seattle, Wash.
Meets: Second Tuesday in Month
President, A. L. POLLARD
601 Electric Bldg.
Secretary, S. D. PETERSON
473 Colman Bldg.

PHILADELPHIA
Headquarters, Philadelphia
Meets: Second Thursday in Month
President, J. H. HUCKER
1700 Walnut St.
Secretary, H. H. ERICKSON
2124 Arch St.

PITTSBURGH
Headquarters, Pittsburgh
Meets: Second Monday in Month
President, L. B. PITTOCK
429-B Oliver Bldg.
Secretary, T. F. ROCKWELL
Carnegie Inst. Tech.

ST. LOUIS
Headquarters, St. Louis
Meets: First Wednesday in Month
President, J. W. COOPER
1596 Arcade Bldg.
Secretary, A. L. WALTERS
7284 Richmond Pl.,
Maplewood, Mo.

SOUTHERN CALIFORNIA
Headquarters, Los Angeles
Meets: Second Tuesday in Month
President, W. E. BARNUM
5051 Santa Fe Ave.
Secretary, P. C. SCOFIELD
748 E. Washington Blvd.

WISCONSIN
Headquarters, Milwaukee
Meets: Third Monday in Month
President, ERNEST SZEKELY
1817 S. 66th St.
Secretary, G. E. HOCHSTEIN
3000 W. Montana St.

Large-Ion and the Small-Ion Content of Air in Occupied Rooms

By G. R. Wait[1] and O. W. Torreson[2] *(NON-MEMBERS)*
Washington, D. C.

INCREASING concern in the ion-content of the air, especially that inside of rooms occupied and unoccupied by people, has been shown in recent years on the part of those interested in problems of ventilation and health. In connection with studies of health, K. Egloff[3] in Davos, as reported by K. Kähler,[4] carried out investigations pertaining to the climate inside of rooms. Included with his measurements were those on condensation-nuclei content and small-ion and large-ion content of air, for the most part in unoccupied rooms, but on occasions with people occupying the rooms as well. Diurnal-variation studies of the small-ion and large-ion content of the air of unoccupied rooms were made, as were also tests to determine the effects on the small-ion content of the air during occupancy of the rooms. At about the same time, Yaglou[5] and his coworkers investigated in this country the small-ion content of air inside of unoccupied rooms and compared the diurnal variation with that for outside air-conditions. Yaglou[6] and associates had made previously a study of the effects of occupancy on the small-ion content of air inside of a closed steel chamber. The results of the latter study on the small-ion content of air is affected by the presence of seven people in the closed steel chamber were not confirmed by the results of Egloff when 40 pupils occupied a closed schoolroom for several hours. The present investigation bears on this point and provides additional information not only on the effect people occupying a closed room have upon the small-ion content but upon the large-ion content as well.

Measurements were made on the small-ion and the large-ion content of the air of a room in the main laboratory of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington; it is believed these may be considered more or less representative of the general office conditions of many individuals. The entire laboratory, including the particular room used for the measurements, was occupied during the daylight working hours, but was unoccupied in general during the night hours, on Saturday afternoons, and on Sundays. Continuous records of the small-ion and the large-ion content of the air of the room were secured, thus providing data from which mean curves are drawn to represent hour-by-hour variations for the room and building occupied as well as unoccupied. Shortly afterwards, records of the same elements were secured in a room of the Administration Building of the Carnegie Institution of Washington during the annual exhibit of 1933, when large crowds of people were present in the room and building. Still later the apparatus was installed in a room of an isolated building on the grounds of the Department of Terrestrial Magnetism, where special tests were made to ascertain in a quantitative way the extent to which a given number of people in the room for a given length of time would affect the small-ion and the large-ion content.

The apparatus used has been described in previous publications.[7] The small-ion counter is so placed that the air-stream first enters this instrument before entering the large-ion counter. The large ions, therefore, are counted from the same sample of air as the small ions. Each ion-counter is provided with its own electrometer, the deflections of which provide a measure of the number of ions collected. The central electrode of the small-ion counter and the electrometer to which it is electrically connected continue to charge up over a period of 54 min; the air-stream is then shut off for 6 min, thus providing hourly records for an insulation-test for the small-ion apparatus and for a zero-count of large ions. The charge on the central cylinder and associated electrometer of the large-ion counter is not allowed to accumulate as in the case of the small-ion counter, but is allowed to flow to Earth through a high resistance (about 10^{12} ohms), the resulting *ir*-drop producing a deflection of the electrometer, which is proportional to the number of large ions present. There is reproduced in Fig. 1 a day's record of the small-ion content and the corresponding record of the large-ion content. A line drawn between the recorded large-ion hourly zero-marks provides the baseline from which to measure the average ordinate. Midway between the hourly zero-marks, there are two dots recorded from automatic calibration of the large-ion electrometer. The small-ion electrometer is calibrated manually at frequent intervals, thus providing ample control of the variables used in the ion-content calculations. The apparatuses have been used to record ion-content of the open air for a long period as well as to record the ion-content of closed rooms.

The closed room at the Department of Terrestrial Magnetism in which the apparatus operated from November 17 to December 7, 1933, being 734 cm by 664 cm and 364 cm high, has a volume of about 179 million cc. This volume was so great that the de-ionizing action of the ion-counters on the air passing through them

[1]Dept. of Research in Terrestrial Magnetism, Carnegie Institution of Washington.
[2]Dept. of Research in Terrestrial Magnetism, Carnegie Institution of Washington.
[3]Dissertation, Eidgen. Tech. Hochschule, Zürich, No. 766.
[4]Naturw., *22*, 461-463 (1934).
[5]*Heating, Piping and Air Conditioning*, A. S. H. V. E. Journal Section, *6*, 25-32 (1934).
[6]A.S.H.V.E. Transactions, Vol. 38, 1932, p. 191.
Presented at the 41st Annual Meeting of the American Society of Heating and Ventilating Engineers, Buffalo, N. Y., January, 1935.

[7]*Terr. Mag.*, *39*, 47-64 (1934).

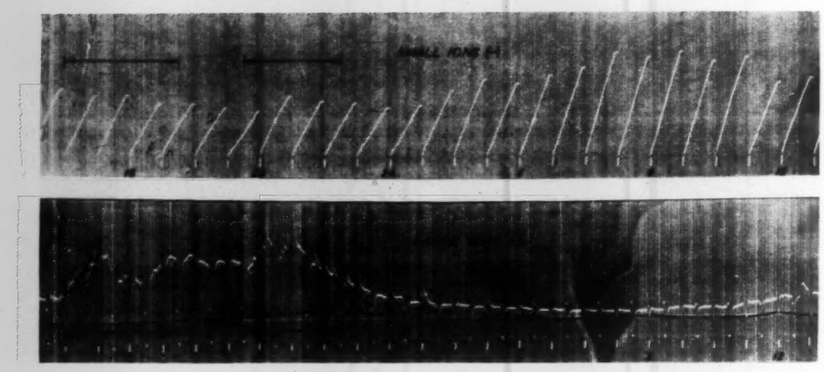

Fig. 1—Typical daily record of small ions and large ions in room of Administration Bldg., Carnegie Institution of Washington, during annual exhibit, December 16-17, 1933 (times noted in 75 deg west meridian mean hours—large number of persons present from 14.h0 to 17.h5 and from 19.h5 to 22.h5 as indicated by arrows)

was not apparent in the results. During regular working hours, the room was occupied by three persons, while there generally were two persons in each of the adjoining rooms. There was occasional smoking of tobacco in the adjoining rooms and in several other rooms of the building but not in the laboratory room. Special tests showed that tobacco smoke affected potently both the large-ion and the small-ion content. All windows and doors were kept closed in the laboratory room to exclude such effects as far as possible. A later test was made to determine whether the effects of occupancy on the small-ion and the large-ion content were due to the presence of the three people in the room or to air-pollution coming into the room from other parts of the building; these will be discussed later.

Records of the small-ion and the large-ion content of the air in the room provide 18 complete days of simultaneous data for study. They have been grouped into four periods, each according to the condition of occupancy of the building and room. All Mondays (building and room occupied from 8 a. m. to 5 p. m.) were placed into the first group, all week-days from Tuesday to Friday (building and room occupied the same as on Monday) were placed in the second group, all Saturdays, including the day before Thanksgiving Day (building and room occupied from 8 a. m. to 1 p. m.) were placed in the third group, and all Sundays (building and room not occupied except for an occasional individual) were placed in a fourth group. The indicated conditions of occupancy were not adhered to strictly and held only for the majority of the time. The week-day group contains six days and each of the others four days of complete record. Mean hourly values of the small-ion content and the large-ion content of the air in the room were obtained for each of the groups. Diurnal-variation curves, beginning with zero-hours Monday and continuing through to midnight Sunday, are shown in Fig. 2. It will be noted that the small-ion content varied in an opposite manner to the large-ion content, both through the day and through the entire period from Monday to Sunday night. The large-ion content was in general high when the building was occupied and low when it was unoccupied. A rapid increase in the content took place almost immediately after the building became occupied and a slow decrease set in from one to several hours after the building was vacated. A gradual accumulation of large ions also took place from Monday morning to Saturday noon, while a slow gradual recovery, in the form of a decrease in the number of large ions, began early Saturday afternoon.

Tests were made to determine whether the changes in the ion-content of the air of the room were due to occupancy of the room or of the building. During one day the room was not occupied, except for a few minutes at 10 a. m. while attending to the apparatus. Fig. 3 gives comparisons of the diurnal variation of both the large-ion and the small-ion content, while the building but not the room, was occupied and while both building and room were occupied. The two sets of curves are similar and thus indicate that the principal effects arise from the building being occupied. There is, however,

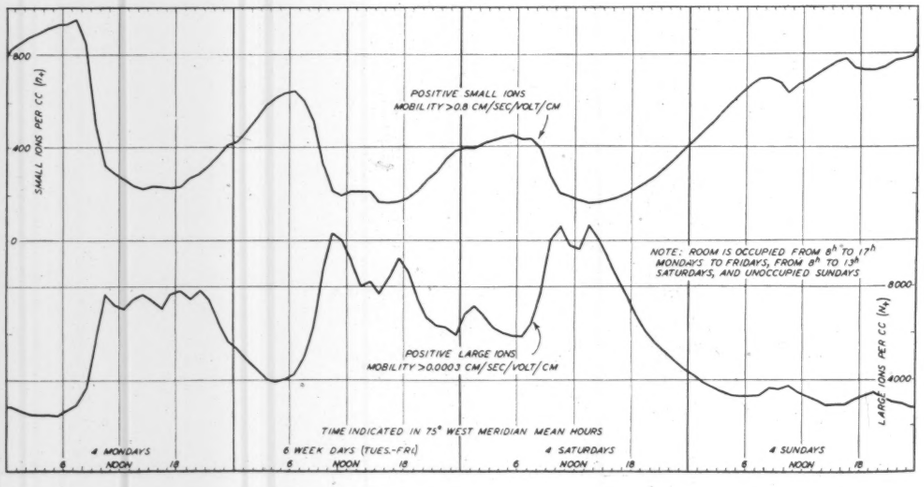

Fig. 2—Effect of occupancy on numbers of small and large ions inside Room 210 in main laboratory, Dept. of Terrestrial Magnetism, Washington, D. C., November 17 to December 7, 1933

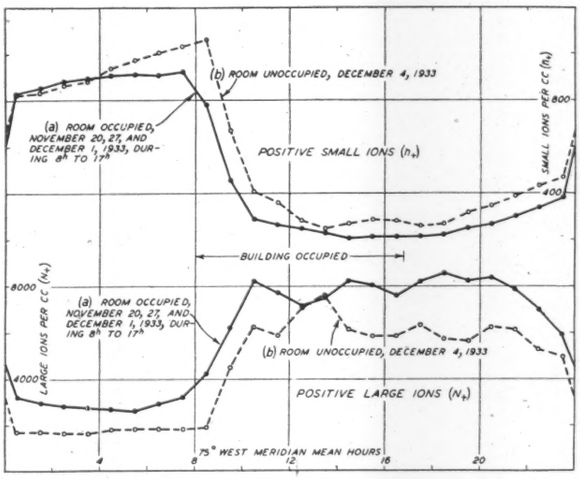

Fig. 3—Small and large ions, (*a*) both building and room occupied, (*b*) building but room not occupied, main laboratory, Dept. of Terrestrial Magnetism, Washing, D. C.

a small consistent difference, the difference in each case being such that it may be attributed to effects arising from occupancy of the room by three persons. The effects from other parts of the building occurred in spite of the fact that all doors and other openings were kept tightly closed in an effort to isolate the room from other parts of the building. The results emphasize that considerable interchange of air may take place between various parts of a building even with all doors and windows closed. Since the effect on the ions came principally from other parts of the building it was surmised that it was largely due to tobacco smoke. Tests were made to determine to what extent this surmise was correct. Conditions could not be controlled within the main building and special tests were made, therefore, after the apparatus was installed in the isolated building, where all conditions with respect to smoking, occupancy, etc., could be controlled. In this test, smoke from one pipe of tobacco and two cigarettes, during an interval of 22 min, was put into the air of the room and the small-ion and the large-ion content were recorded. The tobacco smoke produced a large increase in the large-ion content and a large decrease in the small-ion content. Both the small-ion content and the large-ion content reversed direction of change soon after smoking ceased, the former gradually increasing and the latter gradually decreasing. This recovery of the two sets of ions continued for more than half a day; the large-ion recovery is shown for one of the tests in Fig. 4. The rate of decrease of large ions ($-dN/dt$) is given by the equation, $-dN/dt = KN$, where K is a constant.

The above results may be explained apparently as follows. Since the smoke particles, when electrically charged, are in effect large ions, the addition of smoke to the air of the room increased the number of large ions; these, combining with the small ions, caused the number of small ions to decrease, more or less corresponding to the increase in the number of large ions. When the smoking was stopped, the charged smoke-particles gradually disappeared from the air, which in turn allowed the small ions to increase in number. The rate of decrease in the number of charged smoke-particles followed the law ($-dN/dt = KN$), as expected were they to disappear from the air as a result of falling out under the force of gravity. This being the case, Stokes' law may be applied to determine the radius of the particle falling out. The radius of the smoke-particle determined on this basis was found to be almost identical to that determined in a similar manner for the large ions recorded during November 17 to December 7, 1933, in the room of the main building. In other words, the rate of diminution of the large ions in the room after the building was vacated, proceeded at almost the same rate as that for the particles composing tobacco-smoke. This evidence may justify the assumption that the large ions recorded were composed principally of tobacco smoke coming into the room from other parts of the building. Their effects were so potent that the effects of the people occupying the room itself were small in comparison. Although this conclusion seemed justifiable, it was considered important to compare the radius of a class of larger particles, as calculated on the basis of Stokes' law, with that measured with a high-power microscope. Particles sufficiently large to be seen with a microscope (talcum powder) were injected into the air of the room of the isolated building, and the number of large ions was measured. The rate of decrease followed the same law ($-dN/dt = KN$) as that for

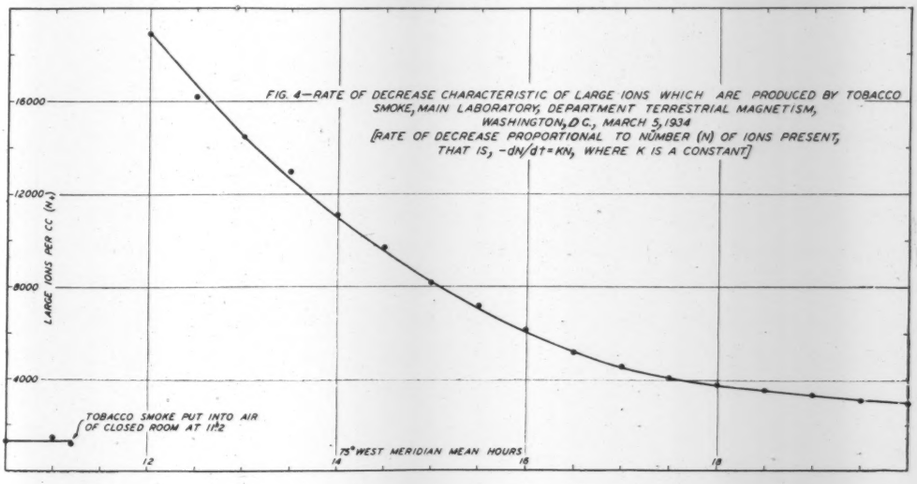
FIG. 4—RATE OF DECREASE CHARACTERISTIC OF LARGE IONS WHICH ARE PRODUCED BY TOBACCO SMOKE, MAIN LABORATORY, DEPARTMENT TERRESTRIAL MAGNETISM, WASHINGTON, D.C., MARCH 5, 1934
[RATE OF DECREASE PROPORTIONAL TO NUMBER (N) OF IONS PRESENT, THAT IS, $-dN/dt=KN$, WHERE K IS A CONSTANT]
16000
12000
8000
4000
LARGE IONS PER CC (N_+)
TOBACCO SMOKE PUT INTO AIR OF CLOSED ROOM AT 11h2
12
14
16
18
75° WEST MERIDIAN MEAN HOURS

Fig. 4—Rate of decrease characteristic of large ions which are produced by tobacco smoke, main laboratory, Dept. of Terrestrial Magnetism, Washington, D. C., March 5, 1934 [rate of decrease proportional to number (N) of ions present, that is, $-dN/dt = KN$, where K is a constant]

smoke-particles. The radius of particle calculated from Stokes' law agreed almost exactly with that determined with the microscope. It was concluded, therefore, that the assumptions made in the application of Stokes' law were justifiable.

Tests were made to determine if the large-ion and the small-ion content of the room was affected through a window being open. Several such tests gave consistent results; typical results are shown by the diurnal-variation graphs of Fig. 5. The effect of the open window is to lower the large-ion content and to raise the small-ion content of the air. The large-ion content, therefore, approaches more nearly that for the outside air, but the small-ion content did not do so; in other words, the small-ion content in the room increased although the small-ion content of the outside air was at the time less than that for the inside air. The small-ion content inside the room is governed, not by the outside conditions, but rather by the large-ion content of the air inside the room, the changes in the small-ion content being in opposite direction to the changes in the large-ion content. The reason for this is that the average life of the small ion is only about a minute or less and sufficient circulation would not ordinarily take place to allow an appreciable number from the outside air to distribute themselves throughout the room.

The tests showed that the small-ion and the large-ion content in the closed room was noticeably affected when a current of air (produced by an electric fan) was directed from a point several feet below the level of the counters towards the intake of the apparatus. Both the small-ion and the large-ion content showed perceptible decreases when the fan was started, the decreases continuing until the fan was stopped. The effect on the large ions was greatest when the large-ion content was large. The effect, therefore, may have been due to smoke-particles accumulating towards the upper part of the room. The decrease in the small-ion content indicates that the ionization near the floor-level was less than that at other levels.

The negative large-ion and negative small-ion content in a room of the Administration Building of the Carnegie Institution of Washington were recorded while the Institution's annual exhibit was in progress during four days in December, 1933. All windows were kept closed but two doors leading to other parts of the building were open during recording. On the first day, December 15, the number of persons present in the building was considerably less than on the three following days. There was occasional smoking in the exhibit-rooms on December 15 but none during the three following days. The hours of the exhibit differed on the first day from those on the three following days; consequently the data have been placed into two corresponding groups for which diurnal-variation graphs are shown in Fig. 6. More-or-less typical daily records are reproduced in Fig. 1. While both sets of ions seem to

Table 1—Average deflections, small-ion and large-ion counters, for given numbers, *N*, of large ions per cc

Large-ions per cc	Deflections in divisions at corresponding times: Large-ion counter D_1	D_2	Small-ion counter d_1	d_2	Differences (D_2-D_1)	(d_1-d_2)
4,000	4.0	6.0	25.0	18.3	2.0	6.7
6,000	16.0	18.0	10.0	9.4	2.0	0.6

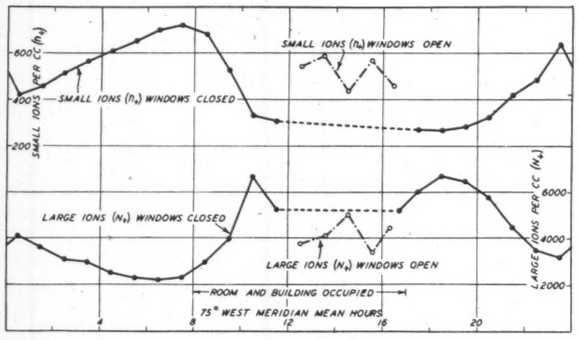

Fig. 5—Effect of open windows on large ions and small ions in occupied room, main laboratory, Dept. of Terrestrial Magnetism ,Washington, D. C., November 22, 1933

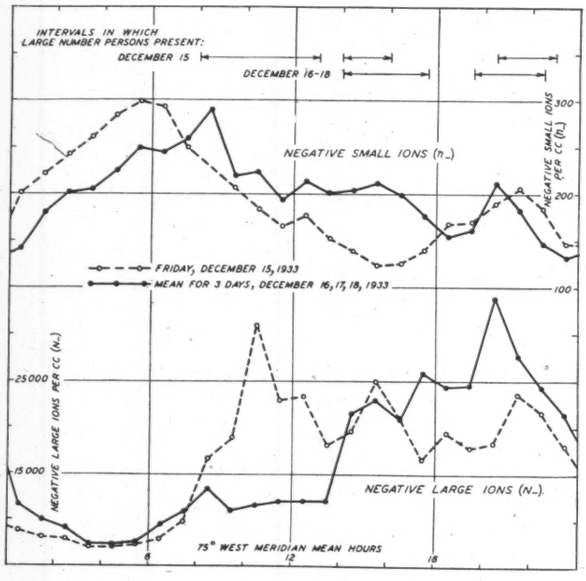

Fig. 6—Ion-content of room, Administration Bldg., Carnegie Institution of Washington, during annual exhibit, December 15-18, 1933

respond in a general way to the effects of occupancy, it is evident that the response of the small ions is less than that of the large ions. Since a reciprocal relationship exists between the numbers of small and large ions in the air, it follows that the small-ion content shows reasonably large responses to moderate changes in the large-ion content, just so long as the large-ion content itself is not great. When the large-ion content is great, the small-ion content changes very little in absolute amount for a given change in the large-ion content. This may be illustrated by average results as given in Table 1.

It is seen from Table 1 that for a given change in deflection of the large-ion counter the corresponding change in deflection of the small-ion counter is much greater for small values of the large-ion content than for large values of this content. Another factor that tends to prevent the small-ion counter from responding to increases in the large-ion content is due to the collection of large and intermediate ions by the small-ion counter. The magnitude of this factor may be large or

Table 2—Numbers of large and small ions in room before and after occupancy by people

Date	Persons in room: Number	Persons in room: Duration	Sign of ions: Large	Sign of ions: Small	Ions per cc before and after occupancy: Before: Large	Before: Small	After: Large	After: Small	Increase in number of large ions: Per minute per person	Per breath
1934		min								
Jan. 23	10	30	+	—	2,750	445	8,400	269	1.17×10^9	78×10^6
Feb. 15	11	30	—	+	4,070	263	10,170	211	1.14×10^9	76×10^6

moderately small, depending upon the particular instrumental arrangements, but at the same time it will depend upon the particular conditions with respect to the number and mobility of large and intermediate ions present. In this investigation this effect has been kept as small as possible, yet permitting the recording of all small ions. From the data of Table 1 it is easy to understand why the small-ion record showed but small response to the effects of occupancy over the interval when the building was occupied, but showed considerable effects later on, in the way of recovery.

The results of Figs. 1 and 6 show that the general effects of occupancy are similar in nature to those due to tobacco smoke, as far as the ionic-content of the air of a closed room is concerned. The effects of tobacco smoke, however, are much more potent than is the breath without tobacco smoke. The experiments indicate that the smoking of one individual may alter the large-ion content content of a closed room as much as about 100 individuals not smoking. One would expect any alteration in the large-ion content of the air of the room, whether due to tobacco smoke or to other conditions, to produce an alteration in the small-ion content of the air. The results given in Fig. 6 indicate that the small-ion content of the air of an occupied closed room is affected by the presence of large ions. This same effect was noted by Yaglou[6], who found that the presence of seven people in a closed steel chamber caused a diminution in the small-ion content from about 250 pairs to about 50 pairs in 90 min. Egloff, on the other hand, failed to find any effect on the small ions due to a schoolroom being occupied several hours by 40 pupils. Additional evidence bearing on this point is desirable, therefore. Tests were made in a room of the isolated building, mentioned in connection with another test, with a given number of persons assembled for 30 min in the room. No smoking took place before, during, or after the tests, so that any effects noted with the ion-counters may be ascribed to that due to occupancy. The room measuring 614 cm by 274 cm by 378 cm high contains approximately 62×10^6 cc. The results of the tests are given in Table 2.

The data of Table 2 furnish additional proof that the small-ion content of the air of a closed room is diminished as a result of people occupying the room, as one would expect on the basis of the reciprocal behavior of the small-ion and large-ion numbers. The absolute change in the small-ion content of the air may not be great and, as indicated above, other effects are present which tend to make any decrease less apparent.

The numbers of large ions per breath in the last column of Table 2 are computed from the data on the assumption that they all came from the breath; the total number of both positive and negative large ions is 154×10^6 per breath. From measurements with an Aitken nuclei-counter in a closed room before and after it was occupied, Wait[8] found the number of condensation-nuclei per breath to be, on an average, about 200×10^6. From comparison with the figure obtained for large ions, one would normally conclude that about 75 per cent of the condensation-nuclei are electrically charged. While the respective tests were not made at the same time, the comparison may give a general indication of that portion which comes from the breath electrically charged. This comparison would be quite fair, except that the number of large ions continually decreased with time as shown in Fig. 7. By assuming that the rate of decrease after the room ceased to be occupied occurred also during the time of occupancy, the computed average number of large ions of both signs per breath is about double that given in Table 2, or about 300×10^6. Comparing this figure with the number of condensation-nuclei measured with the nuclei-counter, after making due allowance for their diminution with time, one infers that about three-fourths of the condensation-nuclei were electrically charged. Since the tests of January 23 and of February 15 gave nearly identical values for the number of large ions per breath and since opposite sign of ions was measured, the indications are that, although most of the condensation-nuclei come from the breath electrically charged, no particular sign pre-

[8] *Jrl. Indust. Hygiene, 16,* 147-159 (1934).

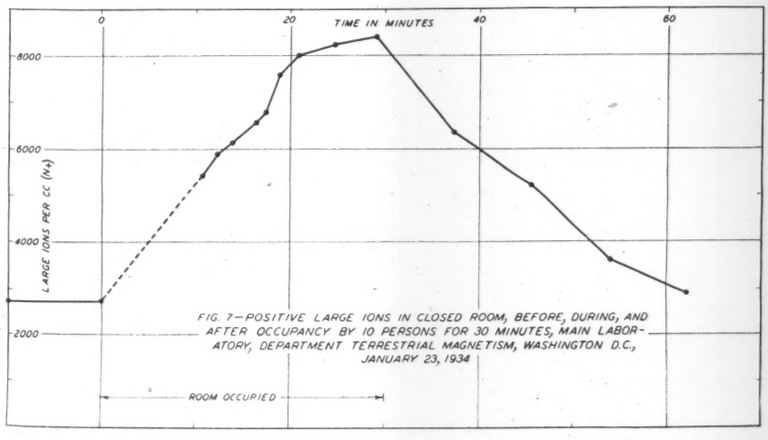

Fig. 7—Positive large ions in closed room, before, during, and after occupancy by 10 persons for 30 min, main laboratory, Dept. of Terrestrial Magnetism, Washington, D. C., January 23, 1934

dominates. Therefore, it seems probable, within the precision of the measurements made, that electricity is not being removed from the body through the breath particles; additional experiments will be required to determine how far this statement is true.

The rate at which the number of particles in a closed room changes depends upon the difference in their rates of production and of disappearance. Fig. 4 shows the rate of disappearance for smoke-particles in the room chiefly due to their falling out under the force of gravity. Were the number of particles in the room to remain constant, then the rate of production must equal this rate of disappearance. If the rate of production be greater than this limit, then the rate of disappearance must be artificially increased (through ventilation) to keep the number of particles constant until the total rate of disappearance again equals the rate of production. Since the rate of disappearance through falling out is slow, the rate of disappearance through ventilation must closely approach that for production. However, for electrically charged particles of breath the rate of disappearance is rapid (Fig. 7) and hence the rate of production can be correspondingly great if the number of particles may remain constant. For a rate of production greater than this limit the rate of disappearance must be increased through artificial means to keep the number of particles constant. Since, however, the rate of disappearance is normally great, the disappearance through artificial means need not be so great as in the case of smoke-particles, assuming equal rates of production. It may be emphasized that the normal rate of production of smoke-particles by one individual smoking is many times that of breath-particles. Assuming it is desirable to prevent an accumulation of particles (smoke or breath) in a room, it follows that the interchange of air through ventilation must be many times that where there is smoking than that where there is no smoking.

The large-ion counter arranged for self-recording should find considerable use in problems of ventilation since much information may be obtained with it. Another instrument which should prove valuable in investigations of ventilation is the condensation nuclei-counter since it deals, not with the number of electrically charged particles but with the total, charged and uncharged; to that extent, it is superior to the large-ion counter. Parallel observations with the two instruments should yield still more valuable information. The development of a continuously recording nuclei-counter is extremely desirable, but would require considerable time and effort and therefore should be undertaken by some organization prepared to give that time and effort.

Summary

(1) Continuous records of the small-ion and large-ion content of the air of a closed room made during several weeks show definite effects due to occupancy, the large-ion content undergoing an increase and the small-ion content undergoing a decrease. A few hours after vacating the room and building the large-ion content began to fall off again. A gradual accumulation of large ions occurred during the period of occupancy with a reverse effect in the small-ion content. All these effects were shown to be due principally to the presence of tobacco smoke or other contamination coming into the room from other parts of the building, even though all windows and doors were kept closed except while someone was passing to or from the room.

(2) Continuous records of the small-ion and the large-ion content of the air of a room were secured while many persons were attending an exhibit in the room and in adjacent rooms. As no smoking of tobacco occurred on three days of the exhibit, the effects noted with the ion-counters were due to causes other than to tobacco smoke. No gradual accumulation of large ions occurred in this case, as occurred in the case of large ions from tobacco-smoke. Occupancy, however, did cause an increase in the large-ion content and a decrease in the small-ion content of the air of the room. Recovery of both large-ion content and small-ion content was much more rapid after the building was vacated than when there was smoking of tobacco.

(3) Special tests after the exhibit showed that the small-ion content of the air of a closed room is appreciably decreased as a result of the room being occupied; these results are in agreement with those of Yaglou but in contradiction with those of Egloff.

(4) The special tests indicate that about 300,000,000 charged nuclei are given out in each breath. This, in conjunction with the results by Wait on the number of condensation-nuclei given out in each breath, indicate that most of the nuclei come electrically charged from the lungs. The results further indicate that as many nuclei are charged with one sign as with the other and therefore appear to be removing no electricity from the body.

Plans and Aims of Bureau of Mines

Following his confirmation by the Senate as Director of the U. S. Bureau of Mines in the Department of the Interior, Dr. John W. Finch has briefly outlined certain plans for making the Bureau a more useful agency, not only in connection with the recovery program of the Administration, but also in respect to the mineral industries as a whole.

For the immediate present the activities of the Economics Branch will be emphasized. This division will be reorganized by realignment of facilities within the Bureau of Mines to concentrate the collection and distribution of economic and statistical data pertaining to the mineral industry in its broader aspects and to meet the requirements of the Government's recovery program.

Dr. Finch believes that, so far as minerals are concerned, advance estimates of demand can best be made by the Government in cooperation with private agencies. The collection of statistics affecting the mineral industries must be continuous and made on a uniform basis for which the Government is well equipped. The Director feels that the Government is in the better position to secure and compare both foreign and domestic data and to make fact-finding studies of tariffs, cartels, mining laws and decrees, as well as to define a just policy of conservation.

Director Finch does not plan to stress economic studies at the expense of other Bureau work, but called attention to the fact that the Bureau of Mines has been subject to drastic curtailment of appropriations.

In discussing work which he plans to resume as soon as funds can be obtained, Dr. Finch mentioned explosives research, study of methods of accident prevention in mines, and the resumption of studies of health of miners and of sanitation in mining communities.

The Director looks forward to increased activity in petroleum research, studies of fuel utilization including those on smokeless combustion, the use of pulverized coal, and the manufacture of gas, coke, and byproducts, etc.

Referring to the Bureau's functions, Dr. Finch stated that it is an organization which endeavors to render friendly and cooperative service.

Sun Effect and the Design of Solar Heaters

By **Harold L. Alt*** ***(MEMBER)***

New York, N. Y.

IN this paper it is intended to give an analysis of the factors entering into the use of sun heat for warming domestic hot water. The solar heater consists essentially of a coil of pipe exposed to the sun's rays so as to heat the water in the pipe and to circulate the water to a storage tank, in much the same manner as employed in the waterback of a kitchen stove, connected with the kitchen boiler. At first thought it might appear that the water, if heated at all, would only reach a lukewarm state and would not attain a temperature sufficient to serve any practical use. Actually, however, under certain favorable conditions, these heaters serve quite well and have the unique advantage of requiring no fuel for operation.

To date, the design of solar heaters seems to have been one of hit-and-miss, modified by the original ideas of the designer, who may have copied one he has seen somewhere else, or gone ahead blindly to the best of his ability with no guidance at all. The result of such conditions is just what might be expected: some of the solar heaters give good service and others do not. In recent years the advance in the art of heating due to research on heat transfer and sun effect problems makes it possible to apply some of the data which have been developed to the design of solar heaters.

Limitations of Solar Heaters

It must be understood at the outset that solar heaters have certain definite limitations and are not suited for all climates and weather conditions. In fact, they are absolutely confined to those localities where sunshine is stable enough to be counted upon every day in the year because, without sunshine there can be no hot water! They also must be located in climates of temperature sufficiently mild so that the water can be heated to the necessary degree and without the danger of freezing or occurrence of too much radiation from the circulation lines and storage tank. Places where solar heaters are in satisfactory use are principally Florida and the southern part of California. They may, however, be used in almost any portion of the southern United States if augmented by some auxiliary method of heating, such as a thermostatically controlled gas heater or a thermostatically controlled oil burning boiler with an indirect heater arranged for summer and winter use.

Solar heaters also must be placed in a position where they will receive the sun's rays during the entire day. At no period of time should they be in the shade of any building, or obstruction while the sun is above the horizon. Usually this position is selected on the roof of a building, but it should be low enough to permit the placing of the storage tank at some distance higher than the coil so as to secure a gravity circulation between the coil and the tank. Much better circulation will be obtained if the coil can be placed on a first story roof, or a porch roof, with the tank in the attic one story above, than if the coil is placed on a low portion of the main roof with the tank in the high portion and only a foot or two between the level of the coil and the bottom of the tank.

Quantity of Water to Be Heated

The quantity of water to be heated will be the same as required in any similar building as only the source of heat is changed, but the source of heat is an intermittent one and cannot be counted upon for much more than an approximate average of 8 hours per day. This does not mean that the sun does not shine more than 8 hours per day, but it does mean that it cannot be relied upon to do any very effective heating of water for a much longer period. Therefore, the tank capacity must be sufficient to carry over the other 16 hours when there is little or no sun heating.

If it is assumed that the average person uses about 40 gal of hot water per day, during sixteen twenty-fourths of the day the consumption based on a straight ratio would amount to 16/24 of 40 gal or about 26 gal. Owing to the fact that a large portion of the 16 hours when no heating is being done occurs at night, also when little hot water is being used, it probably is sufficient to allow only one-half of the quantity of hot water being used during this 16 hour period instead of the two-thirds resulting from a straight ratio. In country locations where people keep early bedtime hours, it might even be slightly less than one-half, but for safety it will be assumed that one-half of the total hot water consumption will occur during the time when the solar heater is not functioning. Therefore the tank must have the capacity to store during the day about 20 gal per person for night use and until the solar heater again goes into operation on the following day.

It is well known that it is impossible to draw the complete amount of stored hot water from a tank without having the incoming cold water cool the remaining hot water down to so low a temperature as to make it unsatisfactory for use, and the amount remaining in the tank when this occurs is approximately 25 per cent. So 25 per cent must be added to the storage capacity to allow the full 20 gal per person to be drawn, making the total storage per person, 20 gal plus 25 per cent of

*Bldg. Equip. Engr., Gibbs & Hill.

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20 gal or 25 gal. Thus, for a family of four persons a tank with 25 gal × 4 or 100 gal would be required.

This is graphically illustrated in Fig. 1 where a 100 gal tank is shown with both the amount of usable water stored for the 16 hour period and the amount remaining in the tank indicated.

The Pipe Coil

In order to receive the greatest amount of heat from the sun, it is evident that the coil should be placed with the pipe surface perpendicular to the sun. As the sun moves daily from the eastern to the western horizons and annually from the farthest north to the farthest south positions, while the pipe coil is fixed in an unchanging position, it becomes evident that the coil must be so placed as to receive the maximum average sun effect for all sun positions. If the coil is placed with one axis running true north and south as shown in Fig. 2, it is evident that it will receive the sun from the east as early, and the sun from the west as late, as any setting that can be devised. This will take care of the daily sun movement from east to west.

In the other direction, allowance must be made for the sun being higher in the sky in summer than it is in the winter and two possibilities suggest themselves. One is to place the coil so the surface will be perpendicular to the sun at noon in its mid-position, as shown in Fig. 3, and the other is to place the coil so that the surface will be perpendicular to the sun at noon in its lowest position. The theory back of the second idea is that a greater amount of heat for the water is required in winter when the sun is at the lowest position and, therefore, that is when the coil should be perpendicular to the noon rays. As the sun comes back north, the outside temperature, water temperature and box temperature all will be higher while the radiation of the tank and circulating pipes will be reduced, thus actually requiring less sun heat to secure the same amount of water warmed to the same degree of temperature. This second position is illustrated in Fig. 4 and has the added advantage of inclining the coil to a greater degree so that air pockets are less liable to form in the coil and so that the coil will be entirely filled with water and work at its highest efficiency.

The point is now reached as to what kind of coil would be best suited for the purpose in mind, remembering that the coil lies flat from east to west but is inclined toward the sun in either the mid position, (see Fig. 3) or the lowest position, (see Fig. 4) as previously noted. This means that the south end of the coil will be lower than the north end, and determines at once that the north end will be the discharge end of the coil while the south end will be the inlet end.

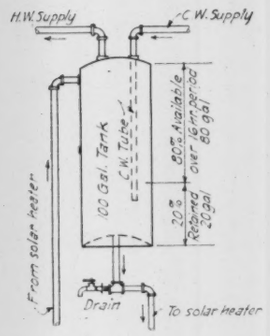


Fig. 1

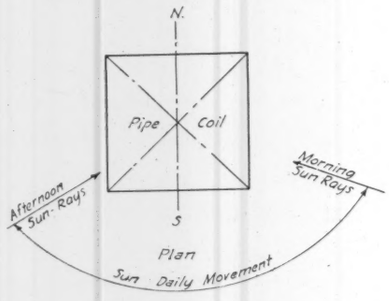


Fig. 2

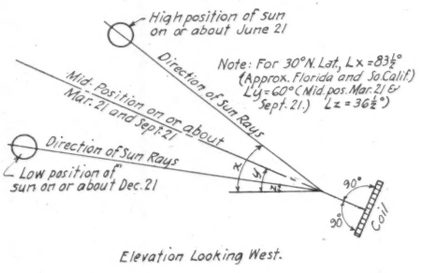

High position of sun on or about June 21
Note: For 30° N. Lat, Lx = 83½° (Approx. Florida and So. Calif.) Ly = 60° (Mid pos. Mar. 21 & Sept. 21.) Lz = 36½°
Direction of Sun Rays
Mid. Position on or about Mar. 21 and Sept. 21
Direction of Sun Rays
Low position of sun on or about Dec. 21
90°
Coil
Elevation Looking West.

Fig. 3

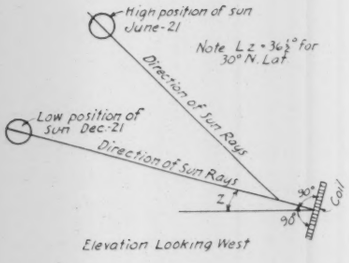


Fig. 4

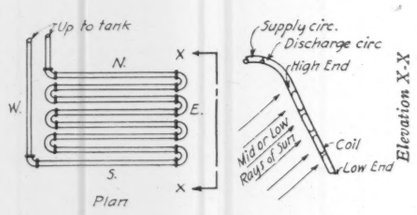


Fig. 5

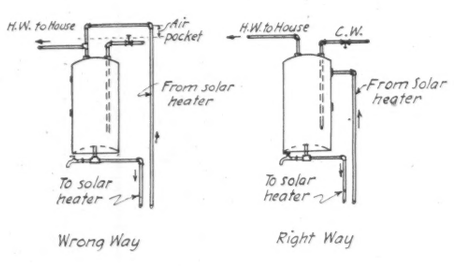


Fig. 6

Design of Coil

The next question is what type of coil will be most desirable and of what material should it be made. Owing to the fact that the coil is to be enclosed in a box, of which more will be said later, it is desirable to have the coil in a square or oblong form; hence a mitre coil is not suited for this work. Neither is a header coil desirable as the water in passing through is heated, and some of the pipes would be at different temperatures from others, resulting in varying amounts of expansion which would tend to open the joints at the header connection. This leaves only the return bend coil to be considered and with such a coil it is readily apparent that the pipes must run from east to west as shown in Fig. 5. If the

pipes are run in a direction from north to south, there will be a higher point in each loop at the north end in which air will collect and interfere with the circulation.

If copper tubing with stream line fittings is employed it would seem that the highest efficiency would result for the following reasons:

1. Copper has a high heat conductivity which would facilitate the transmission of heat into the water.
2. The stream line fittings permit the flow of water with the least amount of friction and would aid in maintaining circulation with the tank especially at times when the tank temperature approaches the coil temperature and the circulation head is slight.
3. This material is non-corrosive with almost any water, there being only a few cases where copper piping will not stand up.
4. It is light and interposes the minimum weight which can be expected.
5. It will not discolor the water with any rust tint at any time in the future.

Galvanized iron pipe coils with galvanized fittings can be used if desired and possibly may be cheaper in some localities. It is probable that a slight increase in the square feet of coil will be necessary, over that required with copper, if galvanized pipe is used. Whether copper or galvanized iron is used is a matter entirely at the discretion of the designer.

Circulation Connections with Tank

The circulation connections with the tank should be of the same material as the coil; if a copper coil is used, the same pipe and fittings should be used up to the tank and back and the tank also should be copper. If galvanized iron is employed for the coil, the circulating pipes also should be galvanized to avoid electrolytic action when copper and galvanized iron are incorporated on the same water line and in contact with each other. It is true that the higher heat transmission of copper will result in a slightly greater heat loss on the circulation lines but this will not amount to anything serious especially as these usually are short and should be properly insulated. Air pockets must be carefully guarded against in the circulation lines the same as on any gravity hot water circulation system and it is desirable to connect the coil discharge line to the highest connection on the side of the tank and not to a connection on the top of the tank where an air pocket will be formed—see Fig. 6.

Insulation of the Tank and Lines

The storage tank should be insulated with some efficient type of insulation, such as hair felt or rock wool, and the insulation should be 1 in. thick. Otherwise there will be quite a heat loss due to radiation from the tank during the 16 hour period when there is no heat supplied by the heater and from the circulation lines during the 8 hours when the heater is in operation. The hot water line from the tank to the fixtures also should be insulated to prevent the drawing off of cooled water whenever a faucet is opened and the wastage of water and heat from this cause. No gravity circulation to fixture outlets can be obtained with this type of hot water supply owing to the height at which the tank must be placed.

Construction of the Hot Box

To secure greater heat transmission to the coil it is customary to locate the coil in a "hot box" which is constructed in most cases of wood with a glass top. This results in the coil receiving heat from two sources; viz., (1) the sun's rays and (2) the heated air in the box. The interior of the box should be arranged to reflect all of the heat possible to the coil and to retain in the box all of the heat possible without transmitting the accumulated heat to the outside air. For this reason all of the interior of the box should be painted white in an effort to prevent the sides absorbing any more heat than necessary and the bottom should be similarly treated. The coil on the other hand should be painted a dull black in order to absorb the heat and transmit it to the water within.

Usually a metallic plate is placed in the bottom of the box with the idea that the sun's rays which do not fall on the pipe will fall on the plate, heat the plate, and that the plate will transfer this heat to the pipe coil by conduction, and by radiation. It would seem that there might be a slight gain in the use of the plate if it were closely bonded into contact with the metal of the coil so as to transmit the heat through the metal rather than via the air.[1] Possibly copper piping with extended fin surface would do this much better but, so far as known, this never has been used.

Coil Efficiency and Amount of Surface

The amount of coil required is a very much disputed point and this is due no doubt to the different positions, types of coil, materials used and climatic conditions under which solar heaters have been built and operated. According to sun tests made as far north as Detroit,[2] for the middle 8 hours of the day—that is from 8:00 A. M. to 4:00 P. M.—the average Btu received on a hot summer day amounts to about 225 Btu per sq ft, on surfaces in a horizontal plane and without any enclosing box. If it is assumed that in a box 5 ft square with a coil, the coil covers roughly one-third of the area, the other two-thirds being space between pipes and around the sides of the coil, the coil will have a projected area exposed to the sun of ⅓ of 5 ft x 5 ft or 8⅓ sq ft. If the coil were made of 1-in. copper tubing, for example, this would amount to 20 1-in. pipes, 5 ft long (including the return bends) and about 3 in. center to center.

The sun heat on the coil would be

$$8\tfrac{1}{3} \times 225 \text{ Btu per hour or } 1{,}875 \text{ Btu per hour}$$

while the remainder of the heat would be dissipated in the box and would amount to

$$16\tfrac{2}{3} \times 225 \text{ Btu or } 3{,}750 \text{ Btu per hour}$$

As the glass on the top of the box absorbs about one-sixth of the sun's heat[3] only five-sixths of the heat calculated can be assumed as actually entering the box, and, due to shadows from the sides, probably only 75 per cent average of the box is effective during the

[1] Copper bottom plates, when used, should be notched out to receive the fittings on the coil in such a way as to allow the coil *pipe* to rest on the plate throughout its entire length and the pipe should be joined to the plate with a continuous solder joint.

[2] See THE A. S. H. V. E. GUIDE, 1934, p. 120.

[3] See Field Studies of Office Building Cooling, by J. H. Walker, S. S. Sanford and E. P. Wells, A. S. H. V. E. TRANSACTIONS, Vol. 38, 1932.

whole 8 hour period. This reduces the figures for heat actually entering the box to

For the pipe

1,875 Btu × ⅝ × 75 per cent or 1,172 Btu per hour.

For the balance of the box

3,750 Btu × ⅝ × 75 per cent or 2,344 Btu per hour.

To make the balance of the calculations, certain assumptions will have to be made and the results checked with the assumptions to see how far off the assumptions may be. It will be assumed, for example, that the outside temperature is 70 F and that the water enters the coil also at 70 F and leaves at about 120 F or a 50 F temperature rise. Then the average water temperature passing through the coil is

$$70\text{F} + \frac{120\text{F} - 70\text{F}}{2} \text{ or } 95\text{F}$$

and, if the pipe absorbs[4] 3 Btu per square foot of external surface, per hour for every degree difference between the temperature in the box and the average water temperature, then the heat absorbed by the pipe per square foot will be

3 Btu × average temperature difference

The coil as previously determined has 20 pipes 1-in. o.d. and each pipe is 5 ft long so the total coil surface is

$$\frac{(1 \text{ in.} \times 3.14)}{12 \text{ in.}} \times 5 \times 20 \text{ ft or } 26 \text{ sq ft plus}$$

Therefore, the heat absorption for the coil from the air in the box will be

3 Btu × 26 sq ft or 78 Btu, per degree t. d.

Now the glass over the top of the box has an area of about 25 sq ft, and transmits about 1.1+ Btu per square foot, per degree difference between the temperature inside of the box and the temperature outside, so that the glass transmission in this case for each degree of temperature difference will amount to

1.1 Btu × 25 sq ft or 28 Btu.

Consequently, for every degree that the box temperature rises above the outside temperature, there will be a loss of heat from the box amounting to 28 Btu and an absorption of heat by the piping in the box of 78 Btu additional. The absorption of heat by the pipe, however, will not begin until after the box temperature *exceeds* the average water temperature of 95 F for the water passing through the coil because, unless the box temperature exceeds the average water temperature, the heat picked up by the coil when the water is *below* the box temperature will be given off by the coil again as soon as the water is heated *above* the box temperature.

These conditions are plotted graphically in the chart shown in Fig. 7 where an arbitrarily assumed temperature rise of 50 F in the box is used to determine the lines for glass transmission and pipe absorption. With 50 F temperature rise in the box the glass will transmit

(120 F—70 F) × 1.1 Btu × 25 sq ft, or 1,375 Btu

and the pipe will absorb

(120 F—95 F) × 3 Btu × 26 sq ft, or 1950 Btu.

These two points have been plotted on the chart above 50 F rise in the box and the glass transmission line has been drawn to 0 Btu for 0 F rise in the box while the pipe absorption line has been drawn to 0 Btu for 25 F rise in the box which corresponds to a box temperature of 95 F below which point all absorption of heat by the pipe from the box air ceases.

The total heat transmitted into the box under the conditions assumed has been calculated to be about 2,344 Btu, which if 25 per cent is assumed as lost in the box, gives about 1,758 effective Btu and this line has been drawn across the chart at 1,758 Btu on the left hand scale. It is evident that, *when* the glass loss plus the pipe absorption equals the total effective heat developed in the box, no further temperature rise in the box can

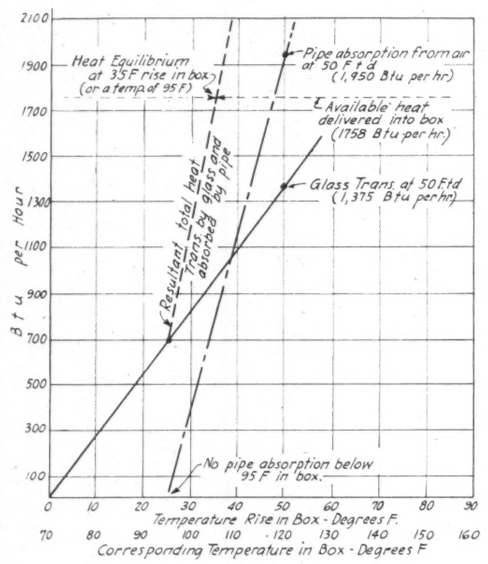

Heat Equilibrium at 35 F rise in box (or a temp of 95 F)
Pipe absorption from air at 50 F t.d (1,950 Btu per hr)
Available heat delivered into box (1758 Btu per hr)
Glass Trans at 50 F t.d (1,375 Btu per hr)
Resultant total heat Trans by glass and pipe absorbed
No pipe absorption below 95 F in box.
Btu per Hour
2100
1900
1700
1500
1300
1100
900
700
500
300
100
0 10 20 30 40 50 60 70 80 90
Temperature Rise in Box - Degrees F.
70 80 90 100 110 120 130 140 150 160
Corresponding Temperature in Box - Degrees F

Fig. 7

be expected. Therefore, if the vertical heights for each of the lines for glass transmission and pipe absorption are added together and a resultant total heat utilized line produced, the point at which this total heat line crosses the horizontal line of effective heat available will be the box temperature which will give a condition of heat equilibrium. This is found to occur at 35 F rise in the box or a box temperature of 105 F.

The heat received from the sun's rays and the heat received from the air in the box may now be combined and the total heat picked up by the coil calculated, this being as follows:

Heat from sun, previously calculated	1,875 Btu
Heat from surrounding air (105 F — 95 F) × 3 Btu × 26 sq ft	780 Btu
Total heat received by the coil	2,655 Btu

The pounds of water per hour which will be heated 50 F with this amount of heat entering the coil will be

2,655 Btu / 50 Btu or 53 lb, or

53 lb / 8⅓ lb, which is 6½ gph (almost)

and in 8 hours this will give

6½ gal × 8 or 52 gal heated during sunlight time.

As there were 26 sq ft of pipe surface in the box, this shows

52 gal / 26 sq ft, or 2 gal per square foot per day

as the heating capacity of a solar coil under the conditions assumed.

The practical result of all of this investigation has been embodied in the two schedules shown in Table 1

[4]Transmission through ferrous pipe, water to air generally is taken at 2 Btu per sq ft, per degree difference per hour but the transmission of copper is roughly as 5:3 making the coefficient for copper 3.33+.

and Table 2; Table 1 is based on the average use of 40 gal of hot water per day per person while Table 2 has the same information modified to suit the rate of 30 gal of hot water per day per person. The designer must select his own basis for his installation although it would seem that the 30 gal rate in most cases would be adequate.

Some criticism of Tables 1 and 2 may be offered on the following grounds:

(a) The amounts of heat received, area of coil, etc., have been calculated on the basis of the sun effect according to tests in Detroit and the sun effect in the southern part of the country would be considerably greater.

(b) The tests even at Detroit were made on a flat surface which is not perpendicular to the sun's rays at any time, even at noon, whereas (with an inclined pipe coil) the projected surface of the coil would be perpendicular with the sun's rays at noon and therefore would receive more heat than indicated by the Detroit tests.

(c) The water used per occupant may be less than that suggested by the two tables one for 40 gpd, and the other for 30 gpd.

(d) The use of double glass on the top of the box would add to the box temperature due to the reduced transmission to the outside air through the glass.

(e) Practical installations are operating with less surface than shown as required by the tables.

To answer these objections categorically, let the question be considered as to what amount of sun heat will be received in latitudes where solar heaters are in use. Reference to Fig. 8 shows the relation of the earth to the sun's rays in both winter and summer for the northern hemisphere where it will be noted that the sun's rays fall vertically on the Tropic of Cancer when the sun is farthest north, as the saying is, and vertically on the Tropic of Capricorn when the sun is farthest south. The farthest north position is reached on, or about,

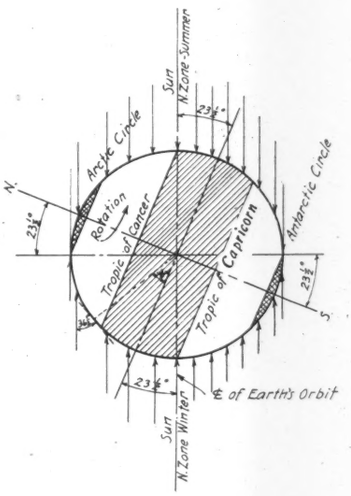


Fig. 8

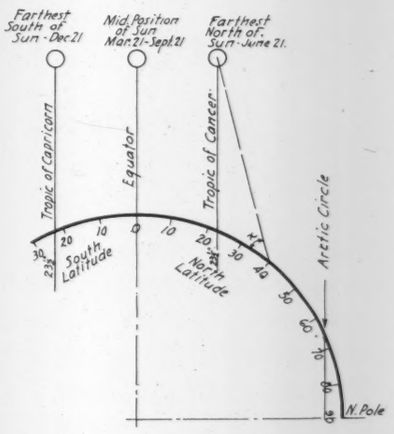


Fig. 8A

June 21st and the farthest south position on, or about, Dec. 21. The time of spring and fall equinox occurs when the sun's rays are vertical over the equator which is on, or about, Mar. 21 and Sept. 21. It will be noted that, in the summer period in the northern hemisphere at the time when the sun is perpendicular over the Tropic of Cancer, the sun's rays are tangent 23½ deg past the north pole—or at the far side of the Arctic circle, while in the winter period when the sun is farthest south, the rays are tangent 23½ deg from the north pole, or at the near side of the Arctic circle.

Table 1

Item of Design (Based on 40 gal Rate)	Number of Occupants in Residence 1	2	3	4	5	6	7	8
	Gallons							
Hot Water Used at Night, per Person	20	20	20	20	20	20	20	20
Hot Water Used at Night, Total	20	40	60	80	100	120	140	160
Retained in Tank, 25%	5	10	15	20	25	30	35	40
Tank Capacity Required	25	50	75	100	125	150	175	200
Hot Water Used During Day	20	40	60	80	100	120	140	160
Total Water to Be Heated in 8-Hour Period	45	90	135	180	225	270	315	360
Water to Be Heated per Hour	6	12	17	23	28	34	39	45
Copper Coil Surface Required in Sq Ft	22	45	66	90	113	135	158	180
Equivalent Length in Feet of 1 in., Copper Pipe	88	180	264	360	452	540	632	720
Box Area in Sq Ft	22	45	66	90	113	135	158	180
Size of Box, Width, Ft	4	6	8	9	10	11	12	12
Length of Box, Ft	5½	7½	8¼	10	11¼	12¼	13¼	15

Table 2

Item of Design (Based on 30 gal Rate)	Number of Occupants in Residence 1	2	3	4	5	6	7	8
	Gallons							
Hot Water Used at Night, per Person	15	15	15	15	15	15	15	15
Hot Water Used at Night, Total	15	30	45	60	75	90	105	120
Retained in Tank, 25%	4	8	12	15	19	23	27	30
Tank Capacity Required	20	40	60	75	95	115	130	150
Hot Water Used During Day	15	30	45	60	75	90	105	120
Total Water to Be Heated in 8-Hour Period	35	70	105	135	170	205	235	270
Water to Be Heated per Hour	4½	9	13	17	21	26	29	34
Copper Coil Surface Required in Sq Ft	17	35	52	67	85	102	117	135
Equivalent Length in Feet of 1 in., Copper Pipe	68	140	208	268	340	408	468	540
Box Area in Sq ft	17	35	52	67	85	102	117	135
Size of Box								
Width in Feet	4	6	7	8	9	10	10	11
Length in Feet	4½	6	7½	8½	9½	10	11½	12¼

In order to find the angle with the horizontal at which the sun's rays strike the earth at noon on any particular date the following formula may be used:

$$\angle x = 90 \text{ deg} - (\text{Lat. of Place} - \text{Lat. of Sun})$$

which formula applies for all conditions when the sun

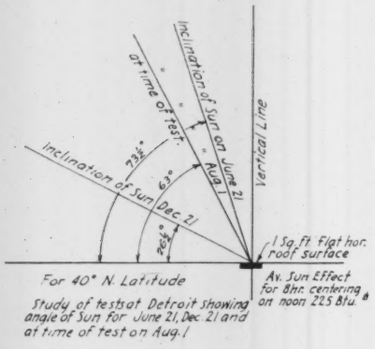

Inclination of Sun at time of test
Inclination of Sun on June 21
Vertical Line
Inclination of Sun Dec 21
73½°
63°
26½°
1 Sq. Ft. Flat hor. roof surface
For 40° N. Latitude
Av. Sun Effect for 8hr. centering on noon 225 Btu.
Study of test at Detroit showing angle of Sun for June 21, Dec 21 and at time of test on Aug. 1

Fig. 9

is north of the equator but which must be modified when the sun is south of the equator to:

$\angle x = 90$ deg. — (Lat. of Place + Lat. of Sun)

when $\angle x$ is the angle of the sun's rays with the horizontal earth's surface.

Lat. of Place equals the latitude of the place where the angle is desired to be found.

Lat. of Sun is the number of degrees that the sun is north or south of the equator as the case may be.

Fig. 8A shows a more detailed diagram of how this formula may be applied. In the first place it will be assumed that the 40th parallel of north latitude covers a typical portion of the earth about 1,000 miles wide and Detroit will be found to lie within this area. Therefore, the angle of the sun's rays at Detroit on the 21st of June when the sun is farthest north will be by the formula

$$\angle x = 90 \text{ deg} - (40 \text{ deg} - 23\tfrac{1}{2} \text{ deg})$$

or

$$\angle x = 90 \text{ deg} - 16\tfrac{1}{2} \text{ deg which is } 73\tfrac{1}{2} \text{ deg.}$$

Similarly, when the sun is in the farthest south position, or directly over the Tropic of Capricorn, the angle x will be

$$\angle x = 90 \text{ deg} - (40 \text{ deg} + 23\tfrac{1}{2} \text{ deg})$$

or

$$\angle x = 90 \text{ deg} - 63\tfrac{1}{2} \text{ deg or } 26\tfrac{1}{2} \text{ deg.}$$

Now the Detroit test was made on Aug 1 or 41 days after the sun had reached the farthest north position and, as the sun moves from the Tropic of Cancer to the Tropic of Capricorn in half a year—or 182½ days—the average movement in degrees per day is

$$47 \text{ deg} / 182\tfrac{1}{2} \text{ da or } 0.26 \text{ deg per day.}$$

In 41 days it had moved

$$41 \text{ da} \times 0.26 \text{ deg or } 10.66 \text{ deg, say } 10\tfrac{1}{2} \text{ deg}$$

Then the latitude of the sun north of the equator at the time of the test must have been approximately

$$23\tfrac{1}{2} \text{ deg} - 10\tfrac{1}{2} \text{ deg or } 13 \text{ deg.}$$

and the angle with the horizontal must have been

$$90 \text{ deg} - (40 \text{ deg} - 13 \text{ deg}) \text{ or } 63 \text{ deg.}$$

This is graphically pictured in Fig. 9. It also may be proved that, if the number of sun rays falling vertically on a square foot of surface is considered as unity, the proportional number of sun rays falling on the same square foot at an angle will vary as the sine of the $\angle x$. See Fig. 10. Therefore, the number of sun rays falling on a horizontal surface at any angle (and, presumably, the sun effect) varies as the sine of the angle at which the rays impinge.

If it is assumed that the 30th parallel of north latitude covers a belt extending approximately 500 miles on

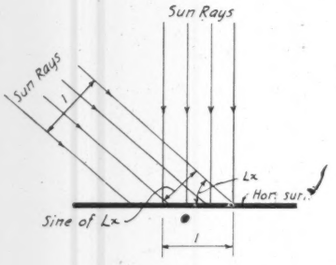


Fig. 10

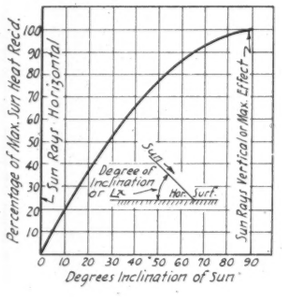


Fig. 11

each side, it will be found that the major portions of Florida and southern California come within this belt and constitute the sections where solar heaters are in use in this country. The angle at which these rays fall, when the sun is farthest north, when it is in mid position, and when it is farthest south, then will be by the previously given formula

$$\angle x = 90 \text{ deg} - (30 - 23\tfrac{1}{2}) \text{ or } 83\tfrac{1}{2} \text{ deg.}$$

$$\angle x = 90 \text{ deg} - (30 - 0) \text{ or } 60 \text{ deg.}$$

$$\angle x = 90 \text{ deg} - (30 + 23\tfrac{1}{2}) \text{ or } 36\tfrac{1}{2} \text{ deg.}$$

With the sun effect as equal to the sine of the impinging angle, and with vertical sun rays as unity, and the angle at Detroit on Aug. 1st as equivalent to an average sun effect of 225 Btu for the 8 hour period centering on 12 o'clock noon, the following table may be developed:

Sin 90	deg,	1.0000	equivalent to 253 Btu average
Sin 83½	deg,	0.99357	equivalent to 250 Btu average
Sin 73½	deg,	0.95882	equivalent to 240 Btu average
Sin 63	deg,	0.89101	equivalent to 225 Btu average (Test)
Sin 60	deg,	0.86603	equivalent to 220 Btu average
Sin 36½	deg,	0.59482	equivalent to 150 Btu average
Sin 26½	deg,	0.44620	equivalent to 113 Btu average.

Based on the sine equivalent of sun effect, a curve may be plotted showing the percentage of the maximum heat sun effect which will be received for any inclination of the sun's rays as indicated in Fig. 11. Owing to the rounded surface of the pipe, it is evident that, when the coil pipes are run in an east and west direction, the projected surface of the coil is always perpendicular to the sun's rays at noon and the coil itself will receive the maximum sun effect regardless of the distance the sun may be above the southern horizon at noon. See Fig 12.

It also is evident that the box will not receive the maximum sun effect except when the bottom of the box is perpendicular to the sun's rays at noon; if the box is set with the bottom perpendicular to the sun rays at their *lowest* angle as has been previously suggested, for 30 deg north latitude this will mean an angle with the horizontal of 53½ deg as shown in Fig. 13. Under this condition possibly 253 Btu could be used as the sun effect against the 225 Btu used in the calculations

presented, but the lower outside temperature—probably around freezing or slightly above—prevailing at such times would increase the glass transmission to a point where the use of this higher figure seems unwarranted.

Use of Double Glass

The use of double glass might be of benefit in cold outside temperatures but if one thickness of glass results

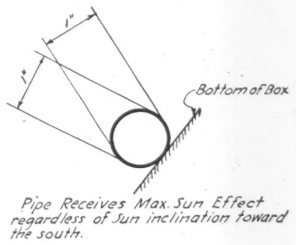


Fig. 12

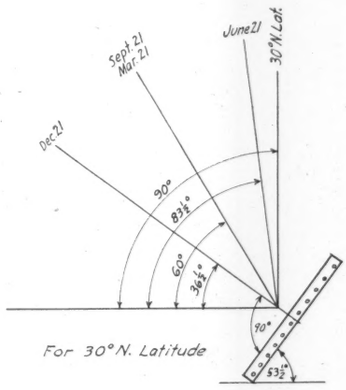


Fig. 13

in the absorption of about one-sixth of the sun heat it is fair to assume that two thicknesses would have about twice this absorption which conclusion is borne out by the tests on double plate glass given in THE A.S.H.V.E. GUIDE 1934.[5] Let the 5 ft x 5 ft box with 100 lineal feet of 1-in. pipe previously considered now be taken with double glass. This gives for the heat effect on the coil

1,875 Btu × ⅔ × 75 per cent or 937 Btu per hour

and for the balance of the box

3,750 Btu × ⅔ × 75 per cent or 1,875 Btu

or, with 25 per cent lost in the box, 1,407 Btu available.

The pipe will still absorb 3 Btu for every degree that the box rises above the average water temperature of 95 F but the heat transmitted out of the box through the double glass will be reduced from 1.1 Btu per square foot, per degree difference, to about 0.45 and this will make the heat loss through glass transmission for every degree rise in the box

25 sq ft × 0.45 or 11¼ Btu

Replotting Fig. 7 on the basis of double glass and in the same manner as previously pursued, it is found that the pipe transmission for 50 F rise in the box remains the same or 1,950 Btu (which is to be expected) and that the glass transmission only reaches 562 Btu under the same rise in the box. The resultant of the two lines crosses the line of total heat available in the box at 38 F or when the box reaches a temperature of 108 F which is only 3 F higher than with single glass. See Fig. 14.

For lower outside temperatures double thicknesses of glass do, however, render some real service as is shown in the comparative curves given in Fig. 15 where the same curves are plotted for 35 F outside and which indicate that the box temperature with single glass would only reach 97 F or 2 F above the average water temperature so that the transmission from the air to the coil would practically be lost under this condition whereas, if double glass were used, the box would reach 109 F in temperature, or slightly better than in Fig. 7 for 70 F outside and with single glass.

The quantity of water to be supplied per occupant must remain a matter to suit the judgment of the de-

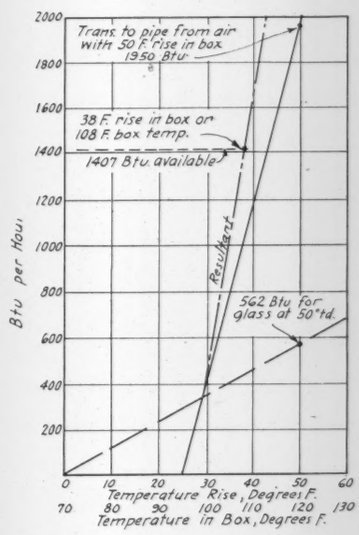

Trans. to pipe from air with 50 F. rise in box 1950 Btu.
38 F. rise in box or 108 F. box temp.
1407 Btu. available
Resultant
562 Btu for glass at 50° td.
Btu per Hour
Temperature Rise, Degrees F.
Temperature in Box, Degrees F.

Fig. 14

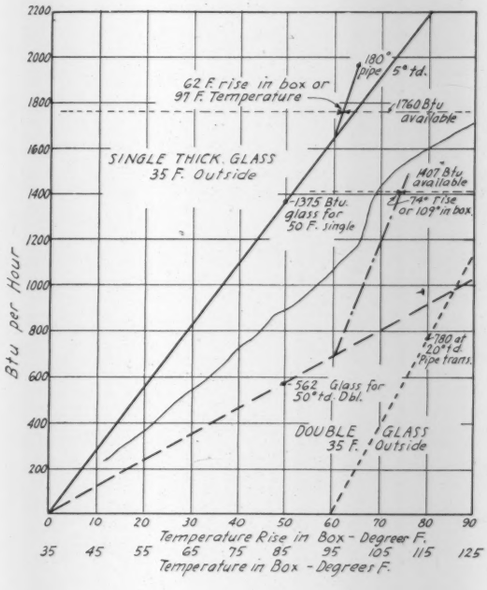

180° pipe 5° td.
62 F. rise in box or 97 F. Temperature
1760 Btu available
SINGLE THICK GLASS 35 F. Outside
1407 Btu available
1375 Btu. glass for 50 F. single
74° Rise or 109° in box
780 at 20° td. Pipe trans.
562 Glass for 50° td. Dbl.
DOUBLE GLASS 35 F. Outside
Btu per Hour
Temperature Rise in Box - Degrees F.
Temperature in Box - Degrees F.

Fig. 15

[5]Page 119.

signer but if 20 gal per day is desired, the Occupants in Table 1 may be considered as doubled and if 15 gal per day is desired the Occupants in Table 2 may be considered as doubled. It has been the aim in this study more to determine the features necessary to supply a given number of gallons of heated water per day under the conditions obtaining with the solar heater than it has been to determine the amount of water which will be required per occupant as this will vary with the type of person and his status of living.

Combinations with Auxiliary Heaters

It might seem feasible to use solar heaters in many localities, where the sun cannot be depended upon at all times, in conjunction with some standby means of heating such as a gas water heater or oil fired steam boiler; by this means the sun heat could be used as long as available and the fuel heater would only come on when the sun heat fails or is exceeded by the load. This should be automatic in arrangement with a thermostat in the storage tank turning on the fuel operated heater only when required. Two typical schemes of such an installation are shown in Fig. 16 where branch circulation pipes are carried down to the fuel heater and the heater is turned on and off automatically by the thermostat located about ⅔ the height of the storage tank. Arrangement should be made to drain the solar heater and piping where temperatures below freezing are encountered.

Conclusions

Several conclusions may be drawn from this study; *first,* that solar heaters, especially when combined with an auxiliary heater, have a much wider application than has been developed to date. *Second,* that they can be made to furnish a considerable supply of heated water at all times of the year when the sun is available in climates where the outside temperature does not go below freezing. *Third,* that the tank storage should approximate 62 per cent of the daily use to include a 25 per cent retention. *Fourth,* that the box should be inclined toward the sun so that the bottom will be at right angles to the sun rays at the lowest southern position on Dec. 21. *Fifth,* that there is no advantage in placing the coil pipes closer together as the sun effect on the coil will not be increased and the size of box cannot be reduced without the loss of some of the sun heat. *Sixth,* that the coil surface in square feet should be not less than 50 per cent of the number of gallons of water to be heated per day. *Seventh,* that double glass is desirable and beneficial in all cases where the minimum outside temperature goes below 60 F. *Eighth,* that the coil piping and circulation lines should not be less than 1-in., size and 1¼-in., would be even better.

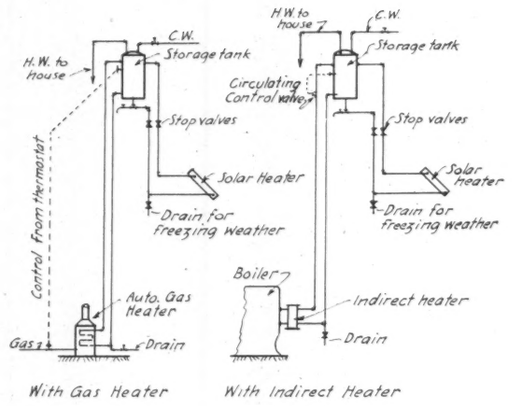


Fig. 16

Data on U. S. Soil Temperatures Correlated

A discussion of each of the following conclusions, together with graphs to illustrate them and summary tables for each of 32 State Agricultural Experiment Stations, specifying conditions of exposure, soil type, soil cover, depth of thermometer, and period of observation, and showing the average monthly and annual temperatures, together with the mean daily ranges and the mean monthly ranges when available, and a bibliography, is included in a paper published in the *Monthly Weather Review.* Where possible, the temperatures used were obtained by averaging the mean daily maximum and mean daily minimum temperatures for each month.

A study of the tabulated records and graphs suggests a number of conclusions, which are given herewith:

(*a*) Air and soil temperatures near the surface vary in a fairly parallel manner.

(*b*) The soil temperatures at slight depths are generally higher than the air temperatures throughout the year.

(*c*) The diurnal range in soil temperatures extends to a depth of about 3 ft.

(*d*) The annual range in soil temperature is quite apparent at a depth of 10 ft, the greatest depth for which a record is obtainable in the United States.

(*e*) The lag of maximum and minimum soil temperatures increases with depth.

(*f*) A cover crop lessens the diurnal and annual temperature ranges.

(*g*) In the winter time, northerly stations, where the snow cover is more or less permanent, show higher mean monthly soil temperatures than stations somewhat farther south or west, but lacking a good snow cover.

(*h*) The presence of moisture in the soil tends to give a low and uniform temperature.

(*i*) Loam, clay, and peat soils never become as warm in summer as the drier gravel and sand soils.

(*j*) Soil temperature and its annual range decrease with altitude.

(*k*) South exposures, at any altitude, have higher temperatures and a greater range than north exposures.

(*l*) In general, the range of soil temperature at a 3-in. depth is about three-fourths the range of air temperature in the warmer half year, and less than two-thirds of the reduced air temperature range in the colder half year.

(*m*) From the general surface layer downward, the daily range decreases geometrically.

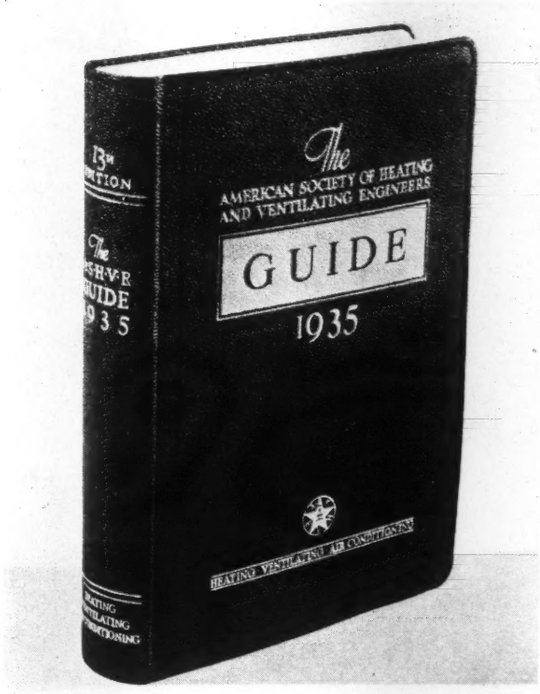
(*n*) Any covering on the soil reduces the daily range markedly.

(*o*) In general, there are much smaller daily ranges at slight depths in winter than in summer, though the range of air temperature is not changed so much.

(*p*) The drier climates generally have the larger daily ranges of soil temperature.

(*q*) In general, the drier months in the warm season have the larger ranges of soil temperature.

(*r*) Monthly ranges are considerable to depths of 12 in. in the north and 24 in. in the south. They decrease fairly rapidly with increase of depth, but proportionally not nearly so fast as the daily ranges.



The A. S. H. V. E. Guide 1935

ENGINEERS, architects, contractors, students and men engaged in trades covering heating and air conditioning have learned to rely on data found in THE GUIDE published annually by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. The 13th edition of this reference book and text has just been released, and copies are now available.

Though the Guide Publication Committee has produced a new book, it has retained from the older ones those data which are basic and fundamental and it has made additions and changes to cover new developments in both theory and practice. More than 200 engineering specialists have helped in the preparation of THE GUIDE 1935. This work of the members and sub-committees has been correlated and edited by the Guide Publication Committee: Walter L. Fleisher, *Chairman*, John Howatt, Prof. G. L. Larson, Samuel R. Lewis, E. N. McDonnell, Prof. W. M. Sawdon, and J. H. Walker, with J. L. Blackshaw as technical assistant.

THE GUIDE 1935 has three divisions. The Technical Data Section, pages 1 to 706, is a reference book and text, which in its 41 chapters covers the fields of heating, air conditioning, cooling, instllation, and ventilation in their theoretical and practical aspects. Starting with factors fundamental to heating and air conditioning—air properties, air distribution, ventilation requirements, heat transmission coefficients of materials and of various structures—it carries on through discussions of the many types of heating, cooling, and conditioning needed, with their applications and methods of accomplishment. It here treats of systems of heating, cooling, and air conditioning; of fuels; of apparatus and machinery; of test methods and instruments.

A Chapter on Sound Control considers the theory and practice of insulating against sound and automatic control devices are fully covered. The machinery and instruments needed for the devices and systems discussed are described in detail. The concluding chapter gives abbreviations, values, symbols and conversion equations for the terms used in this text and related ones.

Wholly new this year in addition to an inserted psychrometric chart is the section called Problems in Practice which supplements Chapters 1 to 40. Made in the form of questions and answers relating to the material presented, these practical treatments summarize each chapter in an interesting and instructive way, and it is felt that this added feature will prove of great value to users of THE GUIDE. A more comprehensive index to the Technical Data Section has been made in order that references may be more quickly checked in the text.

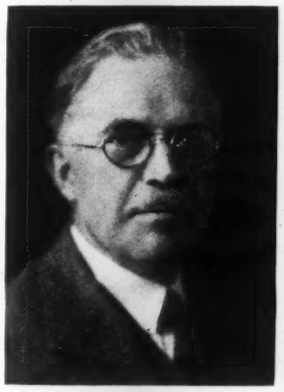
A major division of THE GUIDE 1935 is the Catalog Data Section of 224 pages listing the products and services offered by leading manufacturers in the field, giving pictures, specifications and ratings. The Index to Modern Equipment which follows lists alphabetically by products the manufacturers who can supply the products named, with ready reference to the individual manufacturer's catalog data.

Included in THE GUIDE is a Roll of Membership of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, made both alphabetically and geographically, with a summary of the committees and officers of the Society.

There are 1024 pages in THE GUIDE 1935 and bound in a flexible red cover, 6 x 9 in. in size, it can be obtained by addressing the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, 51 Madison Ave, New York, N. Y., at a cost of $5.00 per copy.

W. W. Macon, Former Secretary, Dies

William Watts Macon, who served as secretary of the A.S. H.V.E. in 1911 and 1912, died on January 1, 1935, at the Murray Hill Hospital, New York City, after a cerebral hemorrhage. His services toward the advancement of the profession during the early days of the Society are memorable for their constructive character. He was greatly interested in heating and ventilating and contributed several papers to the Society, which he joined in 1908.



W. W. Macon

Mr. Macon, who also was formerly editor of *Metal Worker* and *Engineering Record*, was managing editor and associate editor-in-chief of *Iron Age* from 1917-1930 and editor-in-chief from 1930 until 1932, when he retired because of illness. Since then he had been a consulting editor to the publication.

Born in New York City on May 19, 1875, he was graduated from Cornell University with the degree of mechanical engineer in 1898. While at Cornell he began his journalistic career as editor of *The Sibley Journal of Engineering* and immediately after graduation, he joined the editorial department of *The Engineering Record* and later became editor.

From 1905 to 1911 Mr. Macon was editor of *Metal Worker*, until he became associated with *Iron Age*, both David Williams Co. publications.

Mr. Macon was a director of Iron Age Publishing Co. and a member of the *American Society of Mechanical Engineers*, the *American Iron and Steel Institute*, the *Association des Ingenieurs de Chauffage et Ventilation de France*, and the *Cornell Society of Engineers* of which he was formerly president. He was treasurer of the Cornell Alumni Corp. from 1918 to 1931, president in 1931 and 1932, and he had been chairman of the Alumni committee of the *Cornell Alumni News*. Other memberships included the English Speaking Union, the Engineers' and Cornell Clubs of New York, and the Engineers' Club of Brooklyn.

The Officers and Council have expressed their sincere sympathy to Mrs. Maud Andruss Macon, and his daughter, Mrs. B. S. Cushman, who survive.

A. S. H. V. E. Officers Elected in 1935

JOHN HOWATT
Chicago, Ill.
President

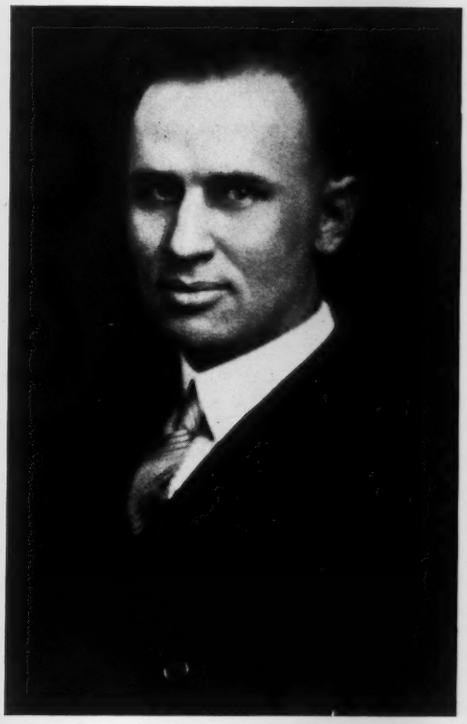
G. L. LARSON
Madison, Wis.
First Vice-President

D. S. BOYDEN
Boston, Mass.
Second Vice-President

ALFRED J. OFFNER
New York, N. Y.
Treasurer

Council Members Elected for Three-Year Term

J. F. McIntire
Detroit, Mich.



Albert Buenger
St. Paul, Minn.

F. E. Giesecke
College Station, Texas

W. E. Stark
Cleveland, Ohio

Local Chapter Reports

Illinois

December 10, 1934. The Illinois Chapter is to be congratulated upon the loyalty of 38 members and guests who did not allow the most severe blizzard of the season to keep them away from an excellent meeting. At 6:30 p. m. they were rewarded by a turkey dinner above the ordinary and good cheer and enthusiasm made up for lack of numbers.

The meeting was called to order at 7:30 p. m. in the Grey Room of the Hotel Sherman by Pres. R. E. Hattis, who announced the names of 11 new members to take advantage of the annual limited chapter membership.

A letter was read from L. S. Ries, recently elected Chapter secretary, who is recovering from a severe illness. Acting Secretary J. J. Hayes was requested to express the hope of every Chapter member that he would be present at the next meeting.

J. F. Hale was called upon to perform a duty in which he took a great deal of pleasure—the presentation of a certificate of life membership in the A. S. H. V. E to his old friend, J. M. Stannard.

Mr. Hale told of the activities of Mr. Stannard, W. A. Pope, and W. B. Graves in the early days of the Illinois Chapter, to whose hard work and loyalty the present success of the Chapter is largely due. Mr. Stannard accepted the honor conferred upon him with a gracious speech.

President Hattis asked Dr. E. V. Hill to introduce the speaker of the evening, N. D. Adams, superintendent of the Franklin Heating Station of the Mayo Clinic, Rochester, Minn. Mr. Adams was active in the design and erection of this plant and now is in charge of its operation.

Mr. Adams gave a very excellent illustrated talk on the many problems encountered in the construction and operation of this steam station, beginning with a brief history of the Mayo Clinic. In the course of his talk, he touched upon boiler and furnace construction, stoker and powdered coal firing, natural gas distribution and firing, boiler and domestic water supply and its treatment, power generation and distribution, heating systems, and many other interesting facts and figures concerning the Franklin Station.

The meeting adjourned at 9:50 p. m. with an enthusiastic vote of thanks to Mr. Adams for his frank and interesting talk.

Cincinnati

January 8, 1935. The annual meeting of the Cincinnati Chapter was called to order by Pres. H. N. Kitchell with 18 members present. E. B. Royer, secretary-treasurer, read the minutes of the previous meeting, which were accepted. The annual report of the treasurer was presented in brief and upon motion of C. E. Hust, seconded by G. B. Houliston, the report was accepted.

The next item of business was the report of the Nominating Committee, which had been sent previously to each member. The president called for additional nominations, whereupon H. L. Stevens moved that the nominations be closed. This motion was seconded by R. B. Breneman and carried. K. A. Wright made a motion, which was seconded by O. W. Motz, that the secretary cast the ballot and the vote on this was unanimously favorable.

The following officers were declared elected:

President—G. B. Houliston
Vice-President—E. B. Royer
Secretary-Treasurer—I. B. Helburn

Mr. Kitchell then addressed the meeting, thanking the members for the loyal support they had given him, and turned over the chair to the newly elected president.

In his talk President Houliston spoke of the necessity of securing additional Chapter members. Various ideas were presented, among which was the suggestion of A. W. Rooks relative to the plan of the Michigan Chapter of having limited memberships in the Chapter for a period not to exceed three years without affiliation with the Society. This matter was left for further discussion at the next meeting.

The letter of Secy. A. V. Hutchinson regarding the Annual Meeting of the A. S. H. V. E. at Buffalo, N. Y., was read and the members were urged to attend.

A motion to adjourn, made by Mr. Hust and seconded by Mr. Kitchell, was carried.

December 11, 1934. The open meeting of the Cincinnati Chapter was called to order by Pres. H. N. Kitchell with an attendance of 39 members and guests.

A motion to postpone all business until the regular weekly noonday luncheon, December 12, was made by K. A. Wright, seconded by C. J. Kiefer, and adopted.

A member of the Chapter, R. B. Breneman, then gave a very interesting short talk on the history of cork as an insulation, going back to the second century, B. C., where records show that bee-hives made of cork were highly esteemed. Mr. Breneman showed a two-reel motion picture on The Story of Cork, which illustrated the harvesting, transporting, and treatment of cork in Spain, as well as giving some local color, including a bull fight.

G. P. Diers, Cincinnati, O., followed with a carefully prepared and well presented talk on The Use of Building Insulation for Economic Heat Control. He also discussed the use and advantages of double glass in windows for preventing condensation and decreasing heat transmission.

A motion picture, showing the manufacture and method of installation of rock wool insulation both in bat and blown-in loose forms, was presented by T. S. Lewis, Cincinnati, O. The first insulation of this type, according to the speaker, was made about 40 years ago and was called mineral wool. Mr. Lewis told of the rapid growth of the use of rock wook insulation in late years, and mentioned its advantage as a fire preventive.

Kansas City

January 14, 1935. The Kansas City Chapter met at 6:00 p. m. at the Newbern Hotel with an attendance of 35 members and 9 guests. Pres. L. A. Stephenson called the gathering to order and the minutes of the December meeting were read and approved.

At the request of Secy. A. V. Hutchinson an invitation was issued for all members to attend the Annual Meeting of the Society in Buffalo, N. Y., January 28-30.

Meeting announcements were read from the Illinois, Cleveland, and St. Louis Chapters, which had been forwarded by the respective secretaries, and it was pointed out by President Stephenson that the Program Committee might be particularly interested.

G. L. Bliss and L. R. Chase were appointed by President Stephenson as a committee to issue a roster of the Chapter membership before the February meeting.

Treasurer Bliss announced that 1935 Chapter dues were payable and that he would appreciate prompt remittance.

D. T. Caleb told of plans to show a sound picture in Edison Hall, February 8, on Sound and invited members of the Chapter to attend.

Secy L. R. Chase read an invitation from the Kansas City Section of the *A.S.M.E.* to attend a movie on boilers at the President Hotel on January 25.

President Stephenson introduced Leon Mart, who gave the Chapter a most interesting illustrated lecture on water cooling devices.

After a short discussion the meeting adjourned.

Michigan

December 10, 1934. Dinner was served at 6:00 p. m. to 90 members and guests who attended the December meeting of the Michigan Chapter at the Dearborn Inn.

After dinner Pres. G. D. Winans asked for a roll call of all persons present and made an announcement regarding an air conditioning meeting scheduled at the Detroit Edison Auditorium on December 18.

The remainder of the meeting was spent inspecting the power plant of the Ford Motor Co. until 10:00 p. m., according to the report of the secretary, W. F. Arnoldy.

New York

January 21, 1935. The subject of corrosion was ably treated by three speakers at the regular monthly meeting of the New York Chapter, held at the Building Trades Club, when approximately 100 members and guests were present.

The first speaker, W. H. Finkelday, discussed the general subject of corrosion of metals and showed the large annual loss caused by this action.

C. M. Sterne gave the results of a number of tests on the use of various chemicals for preventing corrosion of air conditioning apparatus. He dealt specifically with the treatment of the spray water, showing how untreated water can very quickly become extremely corrosive. In concluding, he stated that a competent corrosion engineer should be called in whenever trouble is encountered.

V. B. Gershon illustrated his talk on Scientific and Practical Aspects of Corrosion and Scale in Boiler Plants and Other Water Systems with a number of experiments which demonstrated the method of treating boiler waters. He described temporary and permanent hardness and the various methods of treating them. Mr. Gershon demonstrated how a colloid, such as gum arabic, can be used to increase the surface tension of the boiler water, so that the substance precipitated by the water treatment does not settle in the boiler or water feed lines. Cause and treatment of boiler scale, caustic embrittlement and metallic corrosion were also discussed by the speaker.

Philadelphia

December 13, 1934. The regular meeting of the Philadelphia Chapter was held at the Engineers Club and Pres. W. P. Culbert called the meeting to order at 8:00 p. m. In the absence of Secy. W. R. Eichberg, M. F. Blankin was asked to act in his place and read the minutes of the previous meeting. Treas. W. F. Smith presented his report, which was approved and ordered filed with the records.

Alexander McClintock, chairman of the Membership Committee, reported that J. A. Walsh had become a member of the Chapter.

President Culbert announced the appointment of the following as the 1934 Auditing Committee: L. P. Hynes, *Chairman,* H. H. Erickson, and A. A. Miller.

F. D. Mensing presented a report of the special committee appointed to recommend changes in the Constitution. This report was approved and the chair was ordered to send notice of it to the entire membership so that a vote could be taken on the proposed amendments at the next chapter meeting.

C. V. Haynes, president of the A. S. H. V. E., was introduced by President Culbert and spoke on The Status of the National Society in 1934. He urged attendance at the Annual Meeting of the Society in Buffalo, N. Y., January 28-30, and also gave some other interesting facts regarding the Society. Mr. Culbert thanked President Haynes for being present and stated that the Chapter deeply appreciated the information which he had presented.

J. D. Cassell, member of the Council, then spoke and further enlightened the members present on some of the points emphasized by Mr. Haynes.

The chairman of the Meetings Committee, A. C. Caldwell, spoke of the annual meeting of the Chapter in January, giving an outline of the program, and urged the attendance of members.

Mr. Caldwell presented the guest speaker of the evening, W. J. Burke, who gave a very interesting talk on the use of aluminum foil for insulation. Mr. Burke's paper was illustrated with slides and a lively discussion followed.

The meeting adjourned at 9:45 p. m.

Pacific Northwest

December 11, 1934. The meeting of the Pacific Northwest Chapter was held at the Shuffleton Station of the Puget Sound Power and Light Co., where members were conducted through the plant in small groups, accompanied by a guide. Arrangements were made by Pres. A. L. Pollard.

The power plant is located at Renton, Wash., just south of Seattle, and has a present capacity of 100,000 hp with an ultimate capacity of 300,000 hp. The power house is 240 ft long, 172 ft wide, and 88 ft high. Three boilers of 2500 hp operate at 450 lb pressure and 750 F.

The inspection of the forced and induced draft fans, the 35,000 kw generators and turbines, together with the 48 oil burners each capable of burning 5 barrels of oil per hour at maximum capacity, was very interesting and instructive to the members of the Chapter.

Pittsburgh

January 14, 1935. In the absence of other officers, the meeting was called to order at 7:50 p. m. by the secretary, T. F. Rockwell, and the minutes of the December meeting were read and approved.

The following members were appointed by Pres. L. B. Pittock to standing committees for 1935:

Program—J. F. Collins, Jr., *Chairman,* W. H. Osterle, and M. L. Carr.
Membership—E. C. Smyers, *Chairman,* H. B. Steggall, and L. S. Maehling.
Attendance—R. J. J. Tennant, *Chairman,* A. F. Giles and R. B. Stanger.

D. P. Hartson was introduced and spoke on the Production and Distribution of Natural Gas, fully illustrating his talk by slides.

The 37 members and guests present at the meeting enjoyed the paper very much and devoted more than a half hour to questioning Mr. Hartson after he had concluded his talk.

Upon motion of E. C. Evans the meeting adjourned at 10:00 p. m.

December 10, 1934. A dinner, served in the office of F. C. McIntosh by members of the 1934 Program Committee, preceded the regular meeting of the Pittsburgh Chapter. Members of the committee were Messrs. Stanger, Beighel, Humphreys, Mehl and Benson.

The business meeting was called to order by Pres. P. A. Edwards at 7:45 p. m. Following the reading and approval of the minutes of the previous meeting, the acting secretary read a letter from Mrs. Josephine Anderson, in which she thanked the Pittsburgh Chapter for its memorial to her husband, the late Dean F. Paul Anderson.

The election of officers was brought up and a motion was made by E. C. Evans, seconded by J. F. Collins, that the nominations be closed and that the slate of candidates presented by the Nominating Committee be elected. The motion was carried unanimously and the following officers were elected:

President—L. B. Pittock
Vice-President—R. J. J. Tennant
Secretary—T. F. Rockwell
Treasurer—H. A. Beighel
Board of Governors—P. A. Edwards, C. M. Humphreys, F. H. Hecht.

The retiring president, Mr. Edwards, surrendered the chair to the incoming president, Mr. Pittock, who then described his plans for 1935.

Mr. Evans discussed briefly the recent activity of the Federal Housing Administration in Pittsburgh. He suggested that the Board of Governors make contact with the proper local authorities and offer the services of the Chapter for the development of the F. H. A. program.

The meeting was then turned over to the Program Committee, who provided entertainment by showing several motion picture films of the Canadian woods and an animated drawing, depicting the operation of a modern central electrical generating station. Liquid refreshments were served and many humorous stories were told before the meeting officially adjourned at 10:30 p. m.

Western Michigan

December 3, 1934. Dinner was served at 7:00 p. m. to 10 members and 6 guests of the Western Michigan Chapter, who met in the English Room of the Rowe Hotel, Grand Rapids.

Following dinner, Vice-Pres. P. O. Wierenga presided in the absence of Pres. S. H. Downs and called the meeting to order. Minutes of the previous meeting were read by the secretary, W. G. Schlichting, and approved.

There being no new business, Vice-President Wierenga introduced the speaker of the evening, C. V. Haynes, president of the A. S. H. V. E. Mr. Haynes described the progress which the Society has made in the last year in increasing its membership and retaining old members by making the payment of dues as easy as possible. President Haynes told of the extensive research work carried on in spite of materially reduced appropriations and urged all of the members to attend the Society's Annual Meeting in Buffalo.

After a general discussion, the meeting adjourned at 10:30 p. m.

November 12, 1934. Twelve members of the Western Michigan Chapter and 24 guests met at Warm Friend Tavern, Holland, Mich., when dinner was served at 6:30 p. m. and music added to the enjoyment of the gathering.

Pres. S. H. Downs called the meeting to order and round table introductions of members and guests were made.

J. H. Van Alsburg was introduced and spoke on Warm Air Registers, Past and Present. Mr. Van Alsburg traced the evolution of registers from the early cast iron type to the modern pressed steel designs.

The meeting later adjourned to the plant of the Hart & Cooley Mfg. Co., where an opportunity was given of seeing registers and allied products in the process of manufacture.

This meeting proved to be very interesting and was thoroughly enjoyed by all those present.

Western New York

January 14, 1935. There was an attendance of 26 members and guests for dinner and 45 at the meeting of the Western New York Chapter at the Touraine Hotel.

M. C. Beman, General Chairman of the Committee on Arrangements for the 41st Annual Meeting of the Society, outlined some of the activities planned for the meeting and read reports of the Banquet, Entertainment, and Ladies Committees.

C. W. Farrar spoke of the enthusiasm noticeable at meetings he has recently attended in Toronto, Cleveland, Pittsburgh, Detroit and New York and he optimistically predicted an attendance of approximately 450 at the January Annual Meeting.

A motion was made and seconded that the secretary cast a ballot for the election of the following officers for the ensuing year:

President—W. E. Voisinet
First Vice-President—P. S. Hedley
Second Vice-President—B. C. Candee
Secretary—J. J. Landers
Treasurer—R. T. Thornton

The principal speaker, L. G. Hector, of the University of Buffalo, gave a very interesting discourse on Television. At the conclusion of his talk he was given a rising vote of thanks in appreciation of his splendid speech.

Wisconsin

December 17, 1934. The December meeting of the Wisconsin Chapter was held in the Rose Room of the Hotel Pfister.

Members and guests had the pleasure of hearing C. F. Hosstetter, industrial engineer, present a paper on Electric Motors and Their Application.

The topic was both interesting and unusual because it covered the entire field of electrical motors and their place in industry today. A most interesting feature brought out by the speaker was the fact that many economies can be made by using the right type of electric motor equipment.

With a hearty Christmas wish for all the members at the meeting, adjournment took place at 9:30 p. m. according to the report of the secretary, G. E. Hochstein.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 42 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by February 15, 1935, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	*REFERENCES*	
	Proposers	*Seconders*
ANDERSON, L. B., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	W. N. Espy *(Non-Member)* J. A. Polson *(A.S.M.E.)*
ANTHES, L. L., Pres., Imperial Iron Corp., Ltd., Toronto, Ont., Can.	F. E. Ellis W. R. Blackhall	H. B. Jenney A. S. Leitch
BOALES, W. G., Mfg. Agent, Detroit, Mich. *(Advancement.)*	J. F. McIntire Edw. Glanz	W. F. Arnoldy G. D. Winans

Bowditch, R. P., Student, University of Illinois, Urbana, Ill.	P. E. Mohn *(A.S.M.E.)* W. H. Severns	W. N. Espy *(Non-Member)* C. W. Ham *(Non-Member)*
Brown, N. A., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	R. F. Larson *(Non-Member)* C. W. Ham *(Non-Member)*
Burkhart, E. M., Journeyman, Frishkarn Htg. Co., Harmony, Pa.	C. M. Humphreys T. F. Rockwell	F. C. Houghten P. Nicholls
Daly, C. P., Contractor, Rantman Plbg. & Htg. Co., Seattle, Wash.	M. J. Hauan W. W. Cox	S. D. Peterson H. M. Hendrickson
Danielson, W. A., Major, Quartermaster Corps, U. S. Army, Washington, D. C.	E. N. McDonnell J. F. McIntire	C. V. Haynes Homer Addams
Faulkner, Gordon, Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	O. A. Leutwiler *(A.S.M.E.)* C. W. Ham *(Non-Member)*
Ficnerski, Paul, Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	O. A. Leutwiler *(A.S.M.E.)* C. W. Ham *(Non-Member)*
Fitzgerald, J. F., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	W. N. Espy *(Non-Member)* C. W. Ham *(Non-Member)*
Fleming, T. F., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	W. N. Espy *(Non-Member)* R. F. Larson *(Non-Member)*
Gallagher, Paul, Student, University of Illinois, Urbana, Ill.	P. E. Mohn *(A.S.M.E.)* W. H. Severns	J. A. Polson *(A.S.M.E.)* J. A. Goff *(A.S.M.E.)*
Gemmill, R. A., Mgr., Air Cond. & Oil Burner Dept., Schuck Elec. Co., Philadelphia, Pa.	P. L. Pryibil J. H. Hucker	W. P. Culbert A. McClintock, Jr.
Giannini, M. C., Faculty Lecturer, New York Univ., New York, N. Y.	A. A. Adler L. L. Munier	C. P. Bliss *(A.S.M.E.)* Walter Tusch
Green, A. W., Draftsman, Jackson Heights, L. I., N. Y.	S. Baker *(Non-Member)* B. B. Mahon *(Non-Member)*	H. G. Meinke W. S. Morrison *(Non-Member)*
Hintz, H. P., Student, University of Illinois, Urbana, Ill.	W. H. Severns C. W. Ham *(Non-Member)*	D. S. Ryan *(Non-Member)* P. E. Mohn *(A.S.M.E.)*
Hugoniot, V. E., Air Cond. Engr., Weber Implement & Auto Co., St. Louis, Mo.	A. L. Walters L. W. Moon	G. W. F. Myers E. A. White
Jeffrey, T. G., Mgr., Bastian Morley Ltd., Toronto, Ont., Can.	O. L. Maddux W. R. Blackhall	T. McDonald G. A. Playfair
Johnson, W. A., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	C. H. Casberg *(A.S.M.E.)* J. A. Polson *(A.S.M.E.)*
Jones, A. T., Mech. Engr., S. A. Armstrong, Ltd., Toronto, Ont., Can.	W. R. Blackhall H. P. Boddington	G. A. Playfair T. McDonald
Jordan, W. D., Mgr. Air Cond. Div., Savage Arms Corp., New York, N. Y.	A. F. Hinrichsen Harry Fiedler	C. R. Place Harold Alt
Karges, Albert, Mgr. & Salesman, The Jas. Stewart Mfg. Co., Ltd., Woodstock, Ont., Can.	O. L. Maddux W. P. Boddington	W. R. Blackhall T. McDonald
Lawlor, J. J., Mgr., The Jas. Robertson Co., Ltd., Toronto, Ont., Can.	H. B. Jenney W. P. Boddington	T. McDonald G. A. Playfair
Lingo, C. K. W., Air Cond. Engr., Florida Power & Light Co., Miami, Fla.	P. L. Davidson A. P. Shanklin	H. P. Gant F. D. Mensing
Logan, T. M., Student, University of Illinois, Urbana, Ill.	P. E. Mohn *(A.S.M.E.)* W. H. Severns	O. A. Leutwiler *(A.S.M.E.)* A. P. Kratz
MacDonald, J. D., Vice Pres., Dominion Radiator & Boiler Co., Toronto, Ont., Can.	T. McDonald W. P. Boddington	G. A. Playfair H. B. Jenney
Moody, L. C., Member of Firm, Isaac Hathaway Francis, Cons. Engrs., Philadelphia, Pa.	A. McClintock, Jr. H. G. Black	W. F. Smith F. D. Mensing
Moore, C. H., Efficiency Mgr., Congress Hotel Co., Lake Forest, Ill.	S. G. Neiler T. F. Hanley, Jr.	John Howatt Philip Drinker
Piwinski, E. J., Student, University of Illinois, Urbana, Ill.	W. H. Severns C. W. Ham *(Non-Member)*	W. N. Espy *(Non-Member)* J. A. Polson *(Non-Member)*
Ransom, C. F., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	O. A. Leutwiler *(A.S.M.E.)* W. N. Espy *(Non-Member)*
Schnitzer, Sidney, Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	R. F. Larson *(A.S.M.E.)* W. N. Espy *(Non-Member)*
Scudder, Barrett, Vice Pres., Jas. P. Marsh Corp., Chicago, Ill.	H. R. Linn W. B. Graves	C. W. DeLand R. E. Hattis

SEELEY, I. R., Student, University of Illinois, Urbana, Ill.	W. H. Severns C. W. Ham *(Non-Member)*	D. S. Ryan *(Non-Member)* P. E. Mohn *(A.S.M.E.)*
STITT, A. B., Plbg. & Htg. Engr., Sears, Roebuck & Co., Stamford, Conn. *(Advancement.)*	M. S. Bloomsburg *(A.S.M.E.)* A. C. Coonradt *(A.S.M.E.)*	R. P. Bell *(Non-Member)* W. C. Rudd *(A.I.E.E.)*
STRAKSON, W. C., Student, University of Illinois, Urbana, Ill.	W. H. Severns C. W. Ham *(Non-Member)*	D. S. Ryan *(Non-Member)* P. E. Mohn *(A.S.M.E.)*
SWIFT, P. F., Mgr., The Carl F. Scheffer Co., Dayton, Ohio.	N. J. Rappel *(Non-Member)* J. J. LaSalvia	William Haas M. J. Gibbons
THETFORD, J. E., Student, University of Illinois, Urbana, Ill.	W. H. Severns P. E. Mohn *(A.S.M.E.)*	C. W. Ham *(Non-Member)* H. J. Macintire *(Non-Member)*
VAUGHN, J. G., JR., Junior Salesman, American Radiator Co., New York, N. Y.	O. O. Oaks F. B. Howell	W. R. Zuhlke J. C. Bruckmann
VIDALE, RICHARD, Air Cond. Engr., Hamlin Air Cond. Co., Buffalo, N. Y.	C. J. Hamlin, Jr. R. P. Cook	B. C. Candee G. F. Erdle
WALKER, W. K., Development Engr., American Radiator Co., New York, N. Y.	W. W. Timmis H. W. Fiedler	R. E. Daly W. R. Zuhlke
WHITMER, R. P., Sec'y, American Foundry & Furnace Co., Bloomington, Ill.	J. H. VanAlsburg A. P. Kratz	S. Konzo A. W. Williams

Candidates Elected

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

BRENNAN, J. W., Sales Engr., American Blower Corp, Detroit, Mich. *(Advancement)*

CARY, E. B., Vice Pres., John P. Jones, Cary & Miller, Inc., Cleveland, Ohio.

GERMAIN, OSCAR, Foreman, Germain Frere, Ltd., Three Rivers, Que., Can.

GILMAN, F. W., Plant Engr., Atwater Kent Mfg. Co., Philadelphia, Pa.

HERRICK, LEO, Mgr., Crane Co., Ft. Smith, Ark.

KICZALES, M. D., Assoc. Mech. Engr., U. S. Army Motion Picture Service, Washington, D. C.

MOORE, H. W., Air Cond. Engr., Frigidaire Corp., Dayton, Ohio.

PLUM, L. H., Industrial Engr., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa. *(Advancement)*

ROSELL, A. F., Civil Engr., Svenska Flaktfabriken, Stockholm, Sweden.

ROTH, H. R., Sales Engr., The Canadian Sirocco Co., Ltd., Toronto, Ont., Can.

SHARP, H. C., Mgr., Smith Oil & Refining Co., Rockford, Ill.

SMOOT, T. H., Chief Engr., Anchor Post Fence Co., Baltimore, Md.

WARD, F. J., Htg. & Piping Contractor, The Frank J. Ward Co., Cold Spring, Ky.

ASSOCIATES

BORUCH, E. R., Sales Engr., Dallas Power & Light Co., Dallas, Texas.

MUSGRAVE, M. N., Pres., Harrison Sales Co., Seattle, Wash.

PERKINS, R. C., Sales Engr., Ilg Elec. Vent. Co., Chicago, Ill.

RIVARD, M. M., Mfrs. Rep., Rivard Sales Co., Kansas City, Mo.

WALLACE, J. B., Dist. Rep., Taco Heaters, Inc., New York, N. Y.

JUNIORS

BOYKER, R. O., Partner, Mac Boyker & Son, Kent, Wash.

GORDON, P. B., Engr., George E. Gibson Co., New York, N. Y.

LOCKHART, H. A., Engr., Bell & Gossett Co., Chicago, Ill.

SCHURMAN, J. A., Air Cond. Engr., York Ice Machinery Corp., Cleveland, Ohio.

STUDENTS

AIKEN, J. F., Student, University of Minn., Minneapolis, Minn.

ANDERSON, S. H., Student, University of Minn., Minneapolis, Minn.

ARMSTRONG, R. W., Student, University of Minn., Minneapolis, Minn.

BARNUM, C. R., Student, University of Minn., Minneapolis, Minn.

BUOT, A. V., Student, University of Minn., Minneapolis, Minn.

BUTTS, R. L., Student, University of Minn., Minneapolis, Minn.

DOVOLIS, N. J., Student, University of Minn., Minneapolis, Minn.

GILL, J. W., Student, University of Minn., Minneapolis, Minn.

GORDON, W. J., Jr., Student, University of Minn., Minneapolis, Minn.

HAATVEDT, S. R., Student, University of Minn., Minneapolis, Minn.

HASLETT, H. M., Student, University of Minn., Minneapolis, Minn.

HOWARD, E. S., Student, University of Minn., Minneapolis, Minn.

KNUDTSON, C. M., Student, University of Minn., Minneapolis, Minn.

KOLINSKY, M. D., Student, University of Minn., Minneapolis, Minn.

KUNS, J. W., Student, University of Minn., Minneapolis, Minn.

LUPIENT, G. C., Student, University of Minn., Minneapolis, Minn.

GELB, AMIEL, Student, University of Minn., Minneapolis, Minn.

MAYNARD, H. R., Student, University of Minn., Minneapolis, Minn.

MILLER, H. A., Student, University of Minn., Minneapolis, Minn.

MJOLSNES, L. O., Student, University of Minn., Minneapolis, Minn.

MYERS, C. R., Student, University of Minn., Minneapolis, Minn.

NELSON, R. A., Student, University of Minn., Minneapolis, Minn.

OSTRIN, ALBERT, Student, University of Minn., Minneapolis, Minn.

PAPPENFUS, W. G., Student, University of Minn., Minneapolis, Minn.

POUCHER, R. C., Student, University of Minn., Minneapolis, Minn.

PUNG, D. W., Student, University of Minn., Minneapolis., Minn.

ROSSITER, P. A., University of Minn., Minneapolis, Minn.

SHAW, H. W., Student, University of Minn., Minneapolis, Minn.

STEINKELLNER, E. J., Student, University of Minn., Minneapolis, Minn.

SWANSON, R. G., Student, University of Minn., Minneapolis, Minn.

SWEATT, C. H., Student, University of Minn., Minneapolis, Minn.

SWEIVEN, C. H., Student, University of Minn., Minneapolis, Minn.

TABOR, C. B., Student, University of Minn., Minneapolis, Minn.

WHALLON, FLETCHER, Student, University of Minn., Minneapolis, Minn.

WHITSON, L. S., Student, University of Minn., Minneapolis, Minn.

WILLIS, L. L., Student, University of Minn., Minneapolis, Minn.

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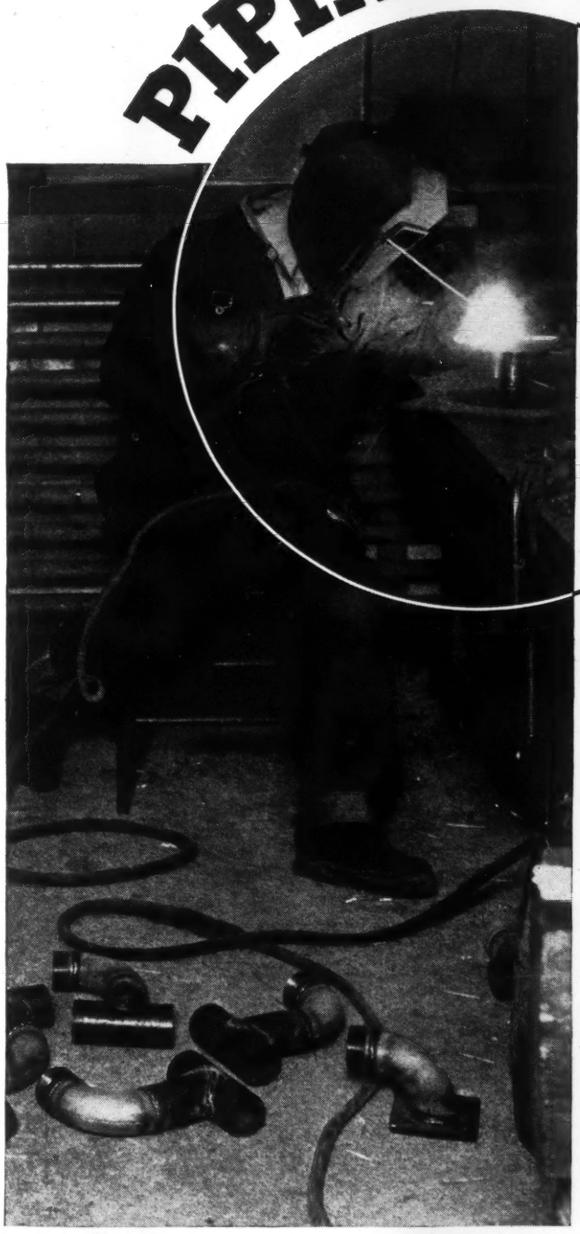

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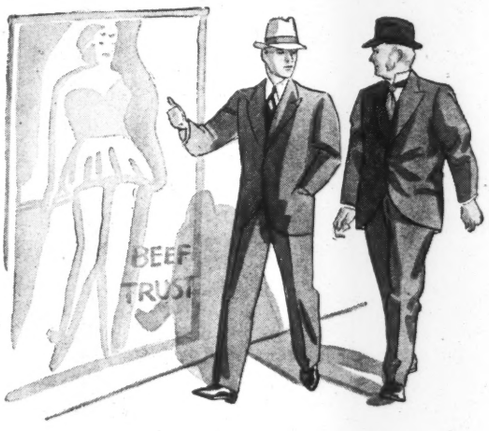

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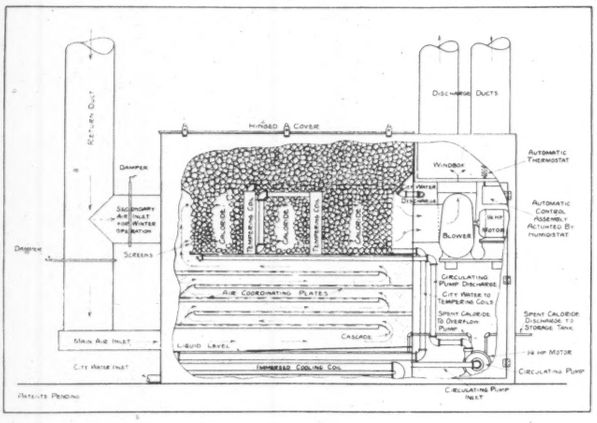
For your convenience in obtaining more information about any of this equipment, see coupon on p. 87

Humidity Control System

No. 152—A new system of controlling humidity for air conditioning for comfort and industrial processing dehumidifies by chemical absorption, a chemical called "Caloride" being used. The only power required is that for operating two ¼ hp motors. The same equipment is used for humidifying during winter, the chemical being replaced by warm water.

In summer, when the relative humidity rises above the humidistat setting, the fan and pump motors go into operation and the unit functions as follows: Air from the space to be conditioned is drawn through the unit (see diagram) in the direction of the arrows, passing several times over the trays containing the liquid Caloride and through wide cascades of the solution pouring over the lips at the alternating opposite ends of the trays. The liquid Caloride is kept in rapid circulation by a centrifugal circulating pump, and a smaller gear pump on the same shaft forces the "spent Caloride" and water removed from the air to the sewer or to the storage tank. During the passage of the air over the trays and through the cascades, a large part of the ultimate absorption of moisture takes place, and the partially dried air is then drawn through the lower portion of the bin containing the lump Caloride, where additional absorption of moisture reduces the relative humidity of the air to between 25 and 26 per cent (which air later mixes with warm air to give the r. h. required). The air, at the same time, passes through the tempering coils located in the Caloride bin, and is sufficiently cooled to counteract the small amount of heat liberated by drying.

For winter operation, the lump and liquid Caloride is removed and warm water admitted in its place. The automatic humidistat control is then set so that the unit operates whenever the

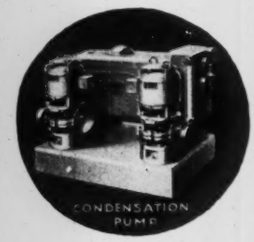


humidity falls *below* the desired point. The function of the unit is now to moisten the air and not to dry it, and this is accomplished by passing the air over the trays and through the cascades, now circulating only warm water. In order to prevent objectionable saturation of the air, the secondary air inlet damper is opened to permit a portion of the comparatively dry return air to mix with the moistened air before being discharged from the unit.—Research Corporation (Calorider Division), Chrysler Bldg., New York City,

Asbestos Pipe Covering

No. 153—A new pipe covering known as "Supercell" is composed of layers or laminations of asbestos felt, 14 to 16 to the

BULLETIN 1100



BULLETIN 800

BULLETIN 700

AMES NRA MEMBER U.S. WE DO OUR PART PUMPS

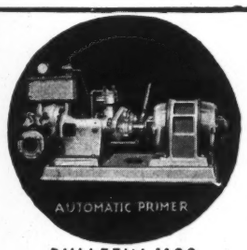
DISTINCTIVELY DIFFERENT

Because—

In designing Ames Pumps, the prime consideration of Ames engineers is, and always has been, to make quality an inherent feature that is expressed in advanced design, workmanship, and above all—pump performance.

A most important, but secondary matter, is the exceptionally attractive price that puts these quality pumps on a very favorable competitive basis.

AMES PUMP COMPANY, INC.
30 CHURCH STREET • NEW YORK, N. Y.
Manufacturers of vacuum heating, condensate, centrifugal pumps, and fuel oil pumping-heating units
Division of American Locomotive Company
Representatives in all principal cities. Products manufactured and sold in Canada by Montreal Locomotive Works, Ltd.



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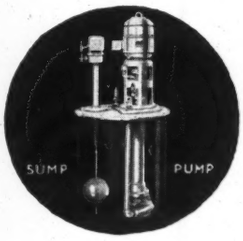

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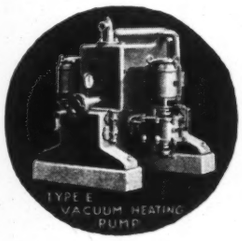


BULLETIN 600

inch thickness, which before being rolled into the covering are surface processed in a special manner which neither fractures nor breaks the fibers of the paper; the processing makes indentations that are close and deep enough to form myriads of dead air spaces.

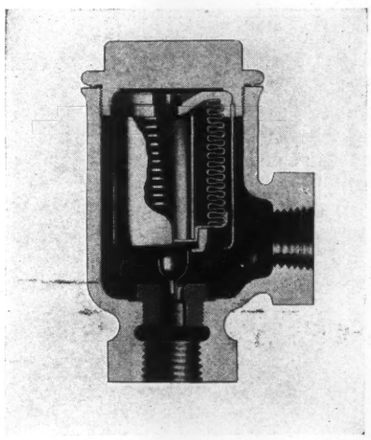
One of the most important features of this covering, says the maker, is the "Pyroxylin" finish applied to the hinged outer casing of asbestos felt and presenting a smooth, glossy, white surface that is dust, water, oil, and grease-proof and which can be washed without injury. The covering can be supplied with a regulation canvas jacket if desired, however.

It comes in ¾ and 1 in. thicknesses, and sheets and blocks of this material are also available. Temperature limit is 500 F.—The Ruberoid Co., 500 Fifth Ave., New York, N. Y.

0-200 Lb Thermostatic Steam Trap

No. 154—A thermostatic steam trap for handling steady and fluctuating pressures from 0 to 200 lb recently placed on the market is expressly designed for individual trapping of high pressure steam coils and jackets in connection with industrial heating and process work.

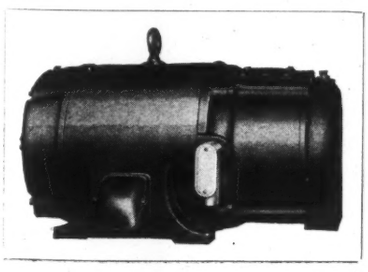
The bellows is made from helically corrugated heavy wall tubing. Special caps are used for the top and bottom of the bellows which have internal screw threads of the same pitch and profile as the flexible tubing, which is screwed right into the cap. This strong mechanical joint is made pressure-tight by sealing with special high temperature solder.



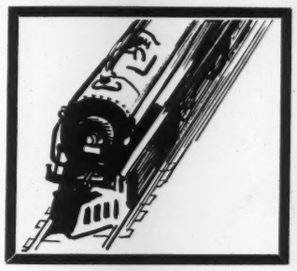
A shield protects the element against abrasive action of steam and permits the element to be removed from the trap body while hot. Body and cap are of heavy cast bronze. A raised face metal-to-metal joint is used between cap and body, no gasket being required. The renewable valve head and seat are of stainless steel, the former being spherical and movably mounted to assure perfect seating.—Sarco Company, Inc., 183 Madison Ave., New York, N. Y.

Splash Proof, Slip Ring, Polyphase Motors

No. 155—A new splash proof slip ring polyphase motor, suitable for installations where the plant is washed down at night or at the end of the day's run or for outdoor installations, is constructed with baffled openings in the lower part of the end bracket to admit cooling air and exclude splashing water. The bearing bracket on the drive end is the same one-piece construction as used on this company's squirrel cage splash proof motors, but the end bracket on the end opposite the drive is constructed with a gasketed covered hand hole for a convenient inspection of brushes and rings, a pipe plug for easy access to the grease plug and a removable section covering the whole end of the bracket which protects the end assembly of the motor. This arrangement renders all parts accessible and splash proof.



RIC-WIL • CAST IRON CONDUIT



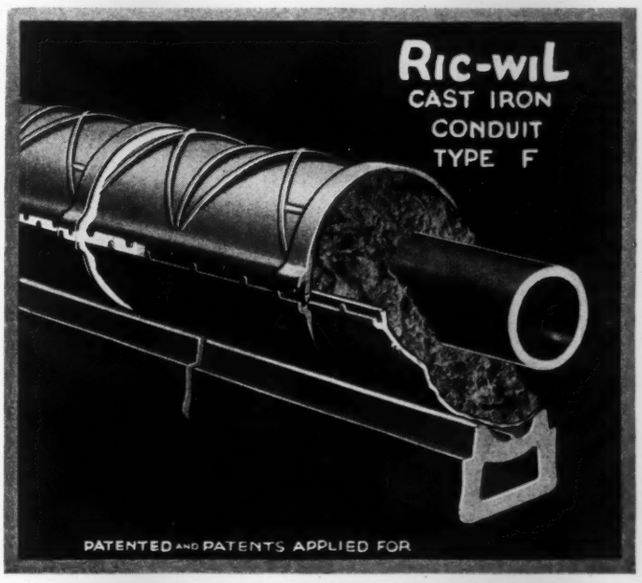
For High Supporting STRENGTH

The new design Ric-wiL Cast Iron Conduit (for use under or near railroad tracks) embodies certain outstanding improvements:

1. Sections in lengths of two feet each—stronger on account of the reinforcing bell every two feet. Short sections are also more practical to handle.
2. New cross-ribbed reinforcing increases the strength.
3. Full open Loc-liP side joints permit continuous cementing without any break, and lugs retain the cement in place against vibration.
4. Internal roller pipe supports (cast integral) obviate any opening in the conduit (desirable with any cast iron system) and speed up installation.
5. Bells are now smaller in diameter than before and slot in the Base Drain Foundation is not required, improving efficiency of drainage system.

Ric-wiL Engineers will gladly consult with you on this or any type of Ric-wiL Conduit System without placing you under any obligation. Write for Bulletin No. A-3411. Revised 1935 Heating Rate Bulletin also sent on request.

The Ric-wiL Co., 1562 Union Trust Bldg., Cleveland
New York San Francisco Chicago.
Agents in Principal Cities



REGISTERED IN U. S. PATENT OFFICE
• RIC-WIL •
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

The frame and end brackets are refined grey cast iron.—Century Electric Company, 1806 Pine St., St. Louis, Mo.

New Safety Switch

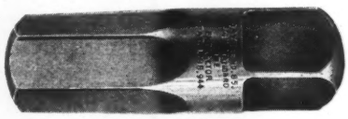
No. 156 — Meeting requirements for a 30 ampere switch, and listed as standard by the Underwriters' Laboratories a new safety switch recently announced is particularly adaptable to oil burners, small stokers, air conditioning equipment, electric unit heaters, as entrance switches, etc. Modern appearance is emphasized in the design.

The switch is small (3½"x5½"x3½"), but provides ample wiring space. To facilitate wiring, the complete mechanism can be removed by loosening two screws, the wires pulled through and the mechanism replaced. Top, bottom, side, and rear knockouts permit easy mounting. The toggle mechanism, front operated, is double pole, positive make and break, and the switch is of the fusible type.

Operating lever is made of a special arc-resisting laminated horn fibre with provision for padlocking in either the open or closed position. The switch is finished in black baked enamel with cadmium trim.—Cutler-Hammer, Inc., 421 N. 12th St., Milwaukee, Wis.

Pipe Extractors for Plant Maintenance Jobs

No. 157—Furnished in sizes for removing broken pipe ends of ¼, ⅜, ½, ¾, 1, 1½ and 2 in. from fittings, valves, etc., the pipe extractor shown here is offered as a plant maintenance tool. The tool functions without spreading the broken ends and will not ream or slip, according to the manufacturer. As engage-



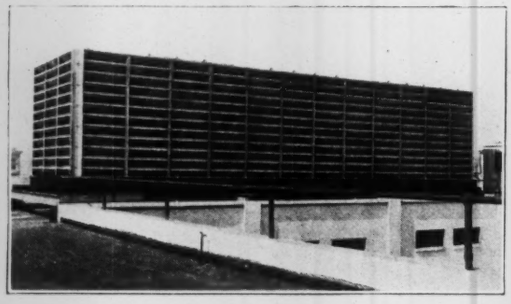
ment of all the flutes to shallow depth occurs immediately upon insertion of the tool and engagement occurs full length of each flute as the tool is driven in, there can be no bottoming of them preventing full flute engagement, it is stated.

This company makes a number of extractors for various plant maintenance operations, together with the accessory drills, etc. They may be had in sets designed to provide the right tool for usual needs, or separately.—Jay Tee Tool Sales Co., 1783 E. 11th St., Cleveland, Ohio.

New Metal Insulation

No. 158—Commercial black steel is used to produce an insulating material which may be applied as a general building insulation, insulating dry kilns, various cold storage and refrigerator purposes, industrial ovens, boiler and pipe covering, etc. Named "Ferro-Therm," this metal insulation consists of parallel spaced metallic sheets with dull or non-bright surfaces, the sheets having low emission and high reflection values at the frequencies of radiant heat.

The thin sheets of steel are formed with angularly arranged surfaces with small ribs at the jointure of the surfaces to secure rigidity, eliminate vibration, prevent propagation of sound waves, and improve insulating qualities. The number of sheets depends upon the temperature difference and desired heat conductivity, the spacing being based on experiments which have been made



COOLING TOWERS

Designed For AIR CONDITIONING WORK

Type "E" Cooling Towers are designed by the Schubert-Christy Corporation expressly for Air Conditioning Service. These towers obtain the cold water temperatures which are necessary for the proper operation of the Air Conditioning Equipment.

Type "E" Cooling Towers are now available for quick shipment in all capacities up to 40,000 G. P. M. They are constructed of California Redwood, Tidewater Red Cypress, Copper Steel and other suitable materials. Write for details and prices.

SCHUBERT-CHRISTY CORPORATION

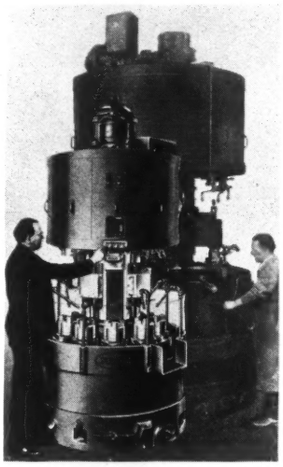
BOX No. 600, AFFTON STATION
ST. LOUIS, MO.

Deck Towers Fan Type Towers Induced Draft Towers Heat Exchangers Spray Towers

to find the best arrangement to eliminate turbulent air flow and provide the greatest insulatng value.—American Flange & Mfg. Co., Inc., 26 Broadway, New York, N. Y.

For Machining Smaller Work

No. 159—Two new machines designed to extend the principle employed in the larger units made by the same company to the machining of smaller classes of work have been announced. Each machine has eight spindles, allowing one station for chucking and seven for work with speeds independently variable to meet the requirements at any station. Both have a wide range of speeds, the smaller unit's initial range running in 41 changes from 168 to 1509 rpm and the larger from 84 to 754 rpm. In addition it is possible to obtain a blanket 2 to 1 reduction of all spindles by means of a dual range change feature.



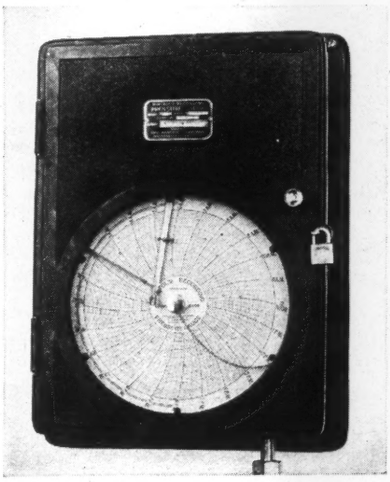
Three push button control stations are located for ease and safety of tool setting as well as operation; each control unit has four separate buttons—emergency control which stops all functions, starting main drive motor, head traverse advance, head traverse return.

Other features include double indexing to provide adaptability where requirements call for first and second chuckings on the same machine; anti-friction bearings throughout; complete automatic pressure lubrication with disconnect switch should lubrication fail. Capacities of the machines, known as "J-7" and "J-11" are respectively 8 and 12 in. in diameter and 10 in. for height.—The Bullard Company, Bridgeport, Conn.

Recording Absolute Pressure Gage

No. 160—A new direct reading absolute pressure gage of the recording type is a recording vacuum gage which is compensated for changes in barometric pressure and for changes in temperature. It, therefore, reads direct in pressure absolute. It has been developed to meet the need in many processes for reading absolute pressure without confusion. The use of high vacuum is now an important feature in production processes such as vacuum processes in oil refineries for instance and many other miscellaneous processes in chemical plants.

The gage is equipped with two measuring elements which are coordinated through a special differential transmitting linkage.



The RIGHT MOTOR for AIR CONDITIONING

For every unit in any Air Conditioning System—Refrigerator Compressors, Fans, Blowers, Pumps—there's a Century Motor exactly suited to meet ALL the requirements of the job, as proved in hundreds of thousands of installations in all parts of the world ... Consult Century Engineers ... You are assured of sound recommendations, backed by more than 31 years of knowing how to build motors that "Keep a-Running"—even under severe operating conditions in unfavorable surroundings ... Sizes up to 600 H. P.

CENTURY ELECTRIC COMPANY
1806 Pine Street St. Louis, Mo.
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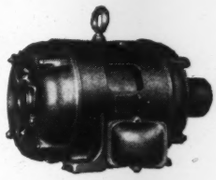


MULTISPEED SQUIRREL CAGE MOTORS

The speed change requirements of Air Conditioning Equipment are most economically met with Century Multispeed Motors. 2, 3, or 4 speeds—Automatic, push button or manual control ... 1/8 to 200 Horse Power.

Get This

Bulletin 6-1, p. 11 tells all about Century's Splash Proof Motors —Slip Ring, Flange Mounting and 2-way Ventilation.

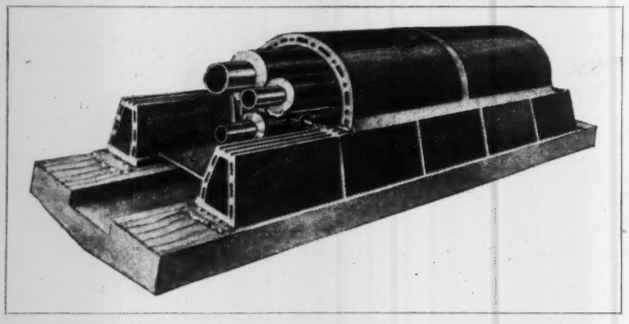
Century

SINGLE PHASE, POLY-PHASE, DIRECT CURRENT
1/250 to 600 H. P.
MOTORS

One measuring element is connected to the vacuum line and the other functions in connection with the compensating features of the recorder. The instrument can be furnished for ranges as low as 25 millimeters head of mercury absolute pressure or its equivalent, is available in rectangular form case of wall type or flush type design.—The Bristol Company, Waterbury, Conn.

Conduit System for Underground Lines

No. 161—A complete conduit system ("Thermotile") for housing, supporting, and insulating underground steam mains has recently been developed. Piping and conduit rest independently of each other on a 4 in. concrete base poured directly into the trench bottom; there is no broken stone fill or underdrain. The



drain is in the form of a channel in the center of the concrete base which draws off water entering during construction and provides an internal drain channel for the pipe space after completion of the installation.

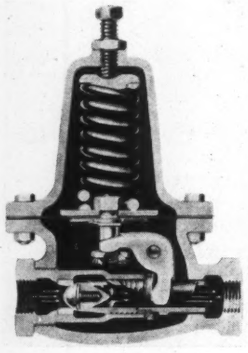
All piping is supported on the concrete base (independently of the tile envelope) on adjustable cast iron supports to prevent strain on the conduit joints. Anchors and guides are attached directly to the slab.

The tile envelope, made from especially selected and blended clays, has double thickness tile sections with integral air chambers. Trapezoidal base sections support the top arch and form air spaces and drainage channels separating the heated space from the earth. Sections are designed to lock the joint cement into grooves and cells in the tile.

Under normal conditions this construction is waterproof but where necessary a waterproof membrane is applied directly to the top of the slab and over the outside of the tile envelope, completely enclosing the conduit and leaving the internal drain in operation.—H. W. Porter & Co., Inc., 825 Frelinghuysen Ave., Newark, N. J.

"Streamlined" Pressure Reducing Valve

No. 162—A "streamlined" pressure reducing valve (in various trims, for all fluids) departs from conventional valve designs in that the valve proper has a blunt nose and a trailing edge. No matter how high the velocity, says the maker, the trailing edge pulls no vacuum to retard flow, the purpose of this scientifically streamlined contour being to insure maximum capacity.



From inlet to outlet, the fluid flows through the valve in a straight line to prevent turbulence or hindrance to maximum flow. A jet extends into the outlet chamber. When demand increases, an accelerated flow through this jet

OVER 400 STYLES AND SIZES TO SELECT

STRONG
Copper Pipe
JOINTS

The Hays Copper Plumbing Method is a mechanically strong method of joining copper pipe. The 2-faced flare of the copper pipe fits perfectly on the 2 seats of the Hays Double Seal Fitting, a 45° plus a 90° joint. (patented)

It's copper to copper with no intermediate sealing agent to ever worry about.

You will be interested in the results of laboratory tests made on all sizes of Hays Double Seal Connections. Write for complete data.

HAYS *Double Seals*

are widely used on Heating, Plumbing and Air Conditioning Copper Pipe lines because of their proven mechanical strength. Every engineer in the field of Air Conditioning is on the alert for trouble free copper pipe connections.

Hays wants every Engineer to know about Hays Double Seals. A comprehensive 24 page catalog is available. Write for your copy today.

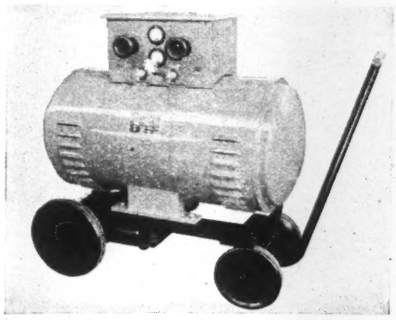
APPROVED BY UNDERWRITERS LABORATORIES

HAYS MFG. CO.
ERIE, PA.

produces an aspirating effect that lowers the pressure in the control chamber (below diaphragm) and thus opens the valve wide to meet peak demand. When the diaphragm moves in a closing direction, the valve proper closes as it is tied to the diaphragm by means of the cam lever. Closing against the pressure of the inflowing fluid the valve will not chatter, according to the manufacturer.—A. W. Cash Company, Decatur, Ill.

Improved Welding Machine

No. 163—Development of a new arc welder featuring unity power motor drive, high over-all efficiency, and a fast arc with high recovery speed has been announced. Generator windings are arranged to utilize a separate auxiliary differential field structure to improve welding performance. This welder will maintain its current and voltage settings when started up cold and run full load for any period desired, the maker states. Tem-



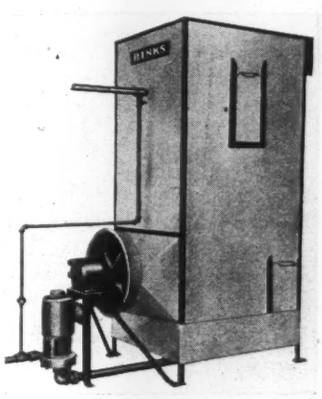
perature rise of the machine has no effect on the current and voltage settings in this welder. It provides both 25 and 40 volt operation by simple adjustment of the controls, permitting use of high speed coated rods, as well as standard uncoated rod, and allowing copper arc and carbon electrode work.

Other features of these "Noel Speed Arc" welders include all-steel welded construction, dual control system for both voltage and current control, polarity reversing switch and zero center individual current and voltage meters. Drip proof covers are provided which upon removal permit access to all parts of the machine. An automatic brake holds the welder from rolling when the pulling handle is lifted. They are also available for direct current motor drive, and engine drives.—The Ideal Electric & Manufacturing Company, Mansfield, Ohio.

New Indoor Forced Draft Cooling Towers

No. 164—Eight different sizes of the new indoor forced draft cooling tower illustrated are now available, ranging in capacity from 5 to 150 gpm circulation. They are recommended by the maker for the cooling of condensing and circulating water for various types of refrigeration and air conditioning equipment and other industrial processes.

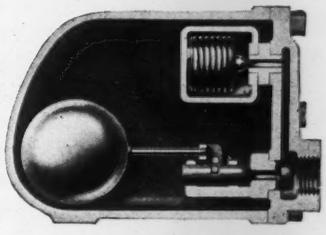
The tower housing is constructed of a heavy gage galvanized copper bearing steel material, provided with interior air deflectors to insure uniform air distribution through the tower from the fan unit. The fan which provides the air circulation is of aluminum alloy. Warm water is delivered to the tower from the condenser or other process to a system of patented "Rotojet" clog-proof nozzles, arranged to provide maximum water breakup and distribution under low pressure to insure maximum cooling effects.



The Sikorsky Aviation Corp., Bridgeport, Conn., write "Installing Sarco Float Traps resulted in an approximate saving of 10% of our oil cost."

By substituting Sarco Float and Thermostatic Traps for traps previously used on 15 unit heaters, they saved about $600.00 a year in fuel bills.

SARCO
FLOAT AND THERMOSTATIC
STEAM TRAPS



will handle condensate in large quantities and in sudden rushes, such as you get in unit heaters, steam coils, hot water service tanks, etc. They can be screwed into the piping without platforms or supports. The thermostatic by-pass valve removes air automatically without loss of steam. Valve head and renewable seat on high pressure types are stainless steel and will not score or wire draw. All working parts mounted on cover for ready access. Write for Catalog O-38.

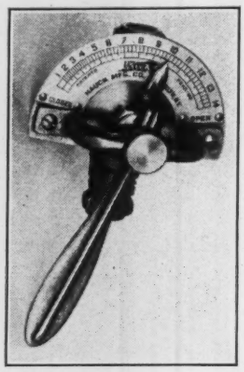
SARCO CO., Inc.
183 Madison Ave. New York, N. Y.
Branches in Principal Cities
Sarco Canada Limited
Federal Bldg., Toronto, Ont., Canada

The two smallest sizes (5 and 10 gpm) are furnished as a complete self-contained unit, and the larger sizes made up in sections which are assembled on the job. All sizes of towers are furnished complete with fan and fan motor, together with water circulating pump where desired, and all sizes can be arranged for automatic operation where necessary. The finished units present an attractive appearance, being sprayed with two coats of aluminum protective paint.—Binks Manufacturing Company, 3106 Carroll Ave., Chicago, Ill.

Regulating Valve Passes Sediment

No. 165—The valve illustrated was originally designed to regulate the flow of fuel oil to burners, but it is applicable to the control of other fluids as well.

This valve has an accurately and minutely variable orifice ob-



tained by the movement of a rectangular slot in a tapered cup shaped portion of the valve stem as it rotates inside a stationary tapered collar and in which the collar has a long triangular or wedge shaped machined opening in circumferential position. As the valve stem is turned, the area of the opening may be increased or decreased by minute increments, or, if desired, can be opened full or shut instantly. The regulating orifice of the valve is concentrated and free, enabling it to pass sediment.

For oil burner operation, by moving the indicator from one graduation point to the next the rate of oil flow is closely regulated; these conditions can be duplicated at any time by resetting the valve at the previously indicated dial reading. The valve can be used for any grade of oil from the lightest distillates to the heaviest residues on any make of burner that requires oil regulation.—The Hauck Mfg. Co., 124 Tenth St., Brooklyn, N. Y.

D-C Motor Operates from A-C Source

No. 166—A revolutionary new type of electric motor, which utilizes a "stationary commutator" and has the characteristics of a series-type d-c machine but which operates from an a-c power source, has been developed by E. F. W. Alexanderson, consulting engineer of the General Electric Company. Known as a "Thyratron" motor, the development is made possible by recent advances in the application of electron tubes. Announcement was made in a paper by Dr. Alexanderson and A. H. Mittag, also of the General Electric Company, which was discussed on January 24 at the *A.I.E.E.* winter convention in New York City.

One motor of this type, intended for use in driving an induced draft fan, has already been built and is now on test. It is rated 400 hp at 625 rpm and 75 hp at 350 rpm. These are the specified ranges of horsepower and speed for the particular application, although the motor may be successfully controlled down to stand-still, if required. The equipment operates from a 2300-volt, three-phase, 60-cycle power supply.

Among the features of this motor are the following:

(1) While running from alternating current, the motor has the characteristics of a series-type direct-current machine.

For positive temperature control in the Hospital

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dependable

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Properly humidified and conditioned air is fast becoming an indispensable aid to modern hospital practice. Silent operation . . . correct temperatures and humidity subject to emergency use . . . specify Baker to meet these important requirements of hospital comfort cooling. Baker Air Conditioning Units are compact, dependable, economical and quiet in operation under all conditions . . . write for details on Baker's complete line of equipment.

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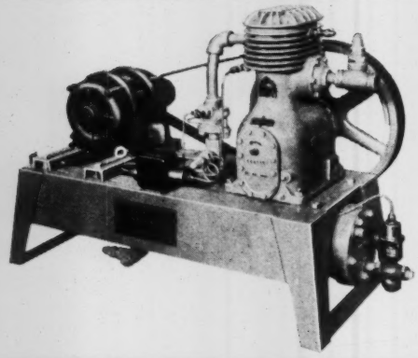
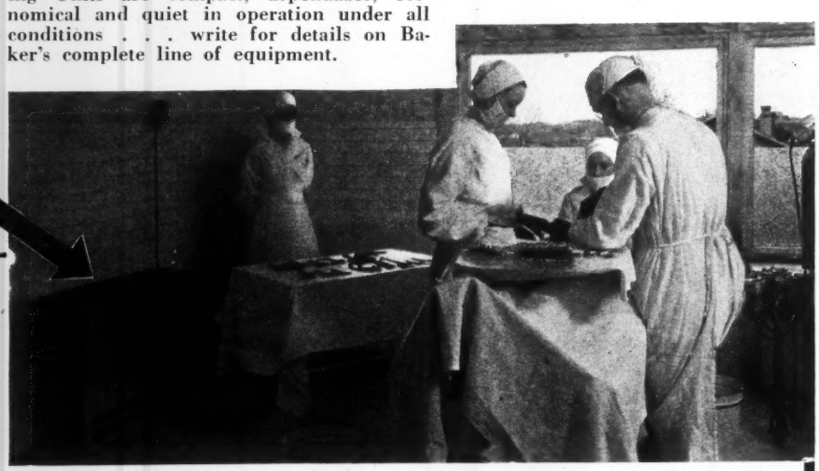


Baker's new freon compressor, for smaller air conditioning applications. Available in 1 to 20 H.P. capacities.



Operating room of All Saints Hospital, Ft. Worth, Texas, showing Baker floor-type conditioning unit.

BAKER ICE MACHINE CO., INC.
1590 EVANS ST. OMAHA, NEBRASKA

Factories:
Omaha Ft. Worth Los Angeles Seattle
Central Sales: Chicago. Eastern Sales: New York.
Sales offices in all important cities.

(2) The speed of the motor is independent of the frequency of the power supply.

(3) Smooth control of the speed can be obtained over the full range.

(4) In event of a momentary interruption of the supply circuit, the motor will, upon the restoration of power, start and return to the speed at which it was previously operating, without drawing excessive current from the line.

(5) The efficiency is high and the efficiency curve relatively flat—a distinct advantage, particularly in the lower portion of the speed range.

Because of these characteristics, motors of this type are applicable to such auxiliaries as fans, centrifugal pumps, compressors, and similar equipment having load characteristics such that the series type of motor can be used to advantage.

The motor has a stationary armature and a revolving field of the type used in synchronous motors. The armature, however, is provided with a special winding. Unidirectional current is supplied by means of a group of full-wave rectifiers which operate from the three-phase 60-cycle current source. The operation of the rectifiers is controlled by means of grids in the tubes so that power is supplied to the motor windings in the proper sequence and amount necessary to give the required torque for operation. This control is obtained by means of a small distributor mounted on one end of the motor shaft. Speed control is obtained by varying the voltage supplied to the motor armature, by means of a phase-shifting device acting upon the same grids in the "Thyratron" tubes. Through this method, it is possible to obtain smooth speed control over the entire range for which the motor is designed.

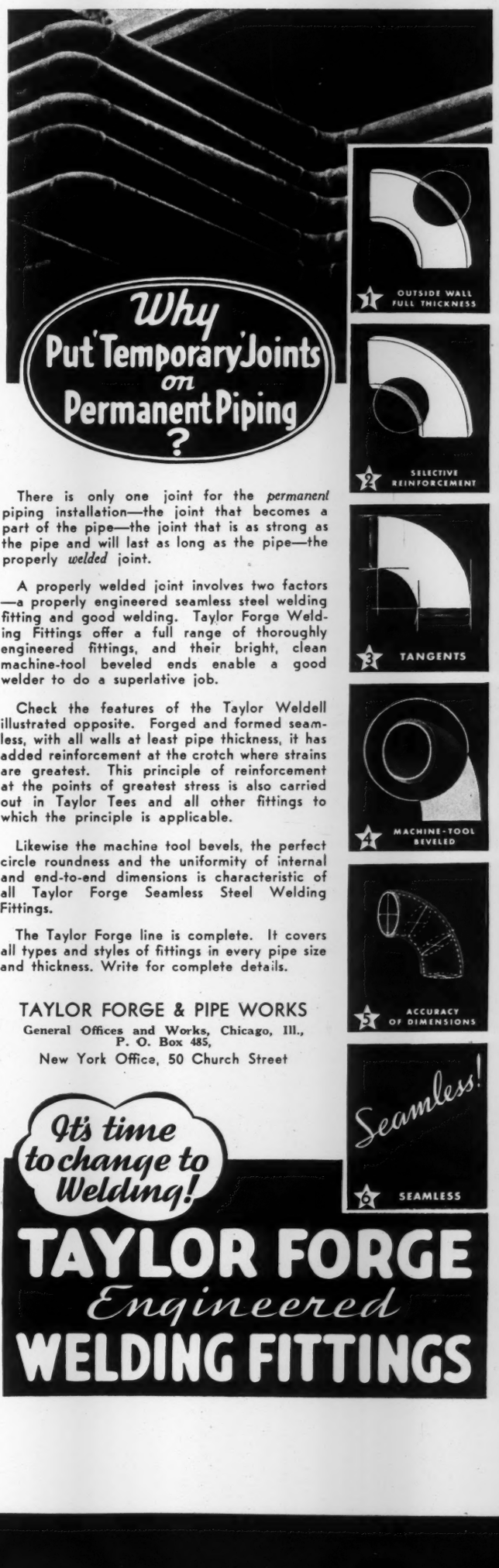
The revolving field of the motor is connected in series with the neutrals of the armature windings and, as a result, the motor has the characteristics of the well-known series-type direct-current motor.

The "Thyratron" tubes, according to Dr. Alexanderson, perform two distinct functions, one being commutation and the other being grid-controlled rectification. Each of these functions has significance in the performance of the new motor. Through the commutator function, the smooth variable speed-torque characteristics of a d-c motor are obtainable, without any reference to synchronism with the power source used. The grid-controlled rectifier function provides the motor with continuous power control from standstill to maximum speed, without wasting power in resistance.—General Electric Company, Schenectady, N. Y.

Tile Conduit Has High Strength

No. 167—A new tile conduit ("Super-Strength") recently put on the market is designed for use under highways or other heavy traffic conditions and is offered as a traffic-proof conduit for all conditions except railway traffic. The tile sections of conduit feature extra heavy walls with special reinforcing at top, bottom and sides to produce balanced construction and maximum strength. Laboratory tests by A. S. T. M. 3-point method show an average crushing strength of approximately 3000 x per foot diameter per lineal foot, reports the manufacturer, the 16 in. size averaging 4,353 lb. These tests indicate sufficient strength to support a concentrated static 6-ton traffic load per wheel under actual installation conditions.

The sections come in 2 ft lengths for all diameters except 26 in., which is 2 ft, 6 in. in length. Features include special base drain, side joint, external pipe supports and interlocking construction throughout. Different types of insulation are optional in this system. An important characteristic, says the maker, is that necessity for expensive special concrete construction is eliminated.—The Ric-wil Co., 1562 Union Trust Bldg., Cleveland, O.


Why Put Temporary Joints on Permanent Piping ?
1 OUTSIDE WALL FULL THICKNESS
2 SELECTIVE REINFORCEMENT
3 TANGENTS
4 MACHINE-TOOL BEVELED
5 ACCURACY OF DIMENSIONS
6 SEAMLESS
There is only one joint for the permanent piping installation—the joint that becomes a part of the pipe—the joint that is as strong as the pipe and will last as long as the pipe—the properly welded joint.
A properly welded joint involves two factors—a properly engineered seamless steel welding fitting and good welding. Taylor Forge Welding Fittings offer a full range of thoroughly engineered fittings, and their bright, clean machine-tool beveled ends enable a good welder to do a superlative job.
Check the features of the Taylor Weldell illustrated opposite. Forged and formed seamless, with all walls at least pipe thickness, it has added reinforcement at the crotch where strains are greatest. This principle of reinforcement at the points of greatest stress is also carried out in Taylor Tees and all other fittings to which the principle is applicable.
Likewise the machine tool bevels, the perfect circle roundness and the uniformity of internal and end-to-end dimensions is characteristic of all Taylor Forge Seamless Steel Welding Fittings.
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New Cooling Tower Uses Multi-Stage Principle

No. 168—A new cooling tower (the "Coey") especially developed to reduce air conditioning condenser water costs utilizes a multi-stage principle of cooling the water, in order to operate efficiently over a wide temperature range so that size and weight of the tower is lessened, and spray loss reduced. A centrifugal fan placed inside the tower in the warm air path to avoid troubles from ice formation is the air moving medium. The fan drive shaft extends below the tower to a motor in a rain-proof enclosure, the fan being direct-connected in the smaller sizes; the larger motors are mounted on a take-up and connected to the fan by a V-belt drive. The tower is built of heavy gauge copper bearing steel, with wood baffles of red Gulf cypress and hot galvanized baffle supports.

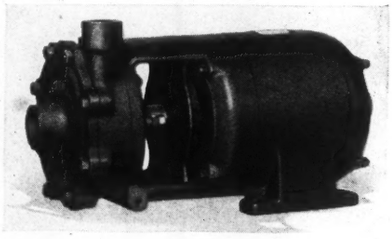
Water to be cooled is introduced through a trough at the top, distributed around the tower by an overflow weir, trickles down over a series of wood baffles. Air entering at the tower bottom passes through this water three times before being exhausted through the spray eliminator at the top. This multi-stage circulation is designed to give the air a long travel in a short tower, secure thorough and uniform contact between air and water, and reduce fan power consumption. Counter-flow circulation (air and water travel in opposite directions) is used so that the coldest water encounters the coldest air to give the greatest possible temperature range.

Opportunities for important savings in air conditioning and refrigeration costs are possible with cooling towers; the makers cite one example of a cooling tower installed in connection with a 46 ton ammonia machine at an industrial plant that saved over $3,000 in four months—more than the cost of the tower.—Research Corporation, 405 Lexington Ave., New York City.

New Pumping Unit

No. 169—An advanced development of a 2 stage "Monobloc" centrifugal pump was recently announced. It is applicable to all services requiring small capacity and medium discharge head, including air conditioning, process work, etc.

The casing, designed to withstand 150 lb pressure, is bolted directly to the motor frame without an intermediate distance piece, eliminating necessity for a baseplate. The impeller design is a unit construction consisting of two enclosed type impellers cast back-to-back, so that the overhung weight will



be no greater than that on a single stage pump. The impeller, which is keyed, is held firmly to the shaft by an impeller nut and the shaft sleeve, also keyed, is a separate, renewable part.

The motor features oversize grease lubricated ball bearings, and the impeller is mounted directly on the motor shaft. The unit can be mounted vertically or horizontally, with full assurance of satisfactory performance in either case.—Worthington Pump and Machinery Corp., Harrison, N. J.

Aluminum Paint

No. 170—A new flexible aluminum paint, which gives a scale-like metal sheathing for longer protection plus a smooth, brilliant finish, has recently been perfected. Dirt and dust do not attach themselves readily to the surface, according to the manu-

facturer, who states that because of excellent water-resistant qualities (including salt water) it stands washing very well, and displays great resistance to chemical fumes, humid atmosphere, corrosion, rust and decay. One standard grade serves equally well both indoors and outdoors.—Roxalin Flexible Lacquer Co., 800 Magnolia Ave., Elizabeth, N. J.

The Editor's Correspondence

Noise in Ventilating Systems

The Editor: May I express my appreciation of the most excellent and instructive articles upon the survey of theaters, by D. D. Kimball. Is it possible for the author to add any comments upon noise generated by the ventilating systems?

Is noise mostly attributable to:

1. Operating machinery,
2. Air noise created by fan runner wheel,
3. High velocities in duct work system?

To what extent is "super silent" machinery employed and insulating materials and devices utilized in mounting blocks and bases?

Are insulating materials and devices employed in duct work systems:

1. To prevent propagation of noise,
2. For internal absorption by means of lining,
3. At gratings?

Are means for cleaning of ducts provided and used, and is the non-cleaning of ducts considered or proved to be seriously detrimental or harmful?—S. F. G., London, England.

Reply: There was found surprisingly little noticeable noise in the operation of the ventilating plants in the theaters inspected. The most in number and the worst noises were due to poorly made and poorly mounted fans, often operating at too high speeds, and often placed close to the inlet grilles to the theater.

Properly located fans, operating at reasonable speeds, on good foundations, give little noise trouble. When placed in the basement and directly bolted to heavy concrete foundations on solid concrete floors the results are usually satisfactory. Generally cork or spring type deadening bases are needed, unless fans are set as last above stated.

The fan wheel rarely causes noise in these systems, as they are now made and installed.

Noise due to high air velocities in the ducts is occasionally encountered.

"Super silent" equipment, if I understand the term, is little used. The cork and spring deadening bases are frequently and successfully used.

"Sound traps" in the ducts, and the lining of ducts are occasionally and successfully used. The latter, employed at the bends of the ducts, usually near the fan outlets, is very successful in eliminating duct noises.

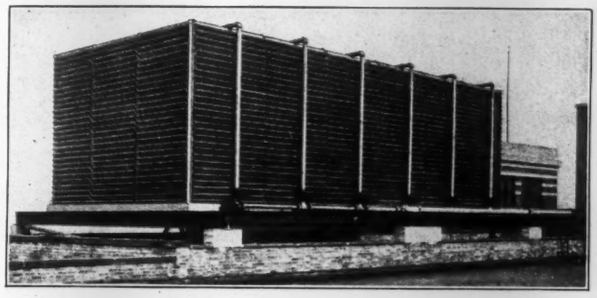
Only one instance of noise originating at the grille was found, and this was due to excessive velocity and light construction of the grille.

Usually no means are provided for the cleaning of the ducts, and they are not often used when provided. They should be provided and used unless all of the air supplied to the theater is either filtered or washed at all times, as otherwise much dust is found in the ducts.—D. D. Kimball.*

*Consulting Engineer, New York, N. Y. Member of Board of Consulting and Contributing Editors.

Operating Hotel Boiler Plant

The Editor: We are subscribers to H. P. & A. C. and we have a boiler problem on which we would like advice. We have an 80 horsepower water tube boiler. In the summer we have a load of 30 horsepower, and our stack temperature is 225 degrees.



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BINKS ATMOSPHERIC SPRAY COOLING TOWERS are built in sizes ranging from 6 tons up to 200 tons refrigeration capacity, and are extensively used today in the ever growing air conditioning field.

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We offer a standardized complete SHOP CONSTRUCTED TOWER (with full spray nozzle distribution) for most every application. This is evidenced by the more than 3,000 Binks Cooling Towers now in operation.

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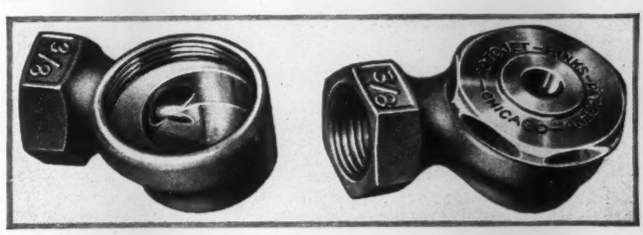

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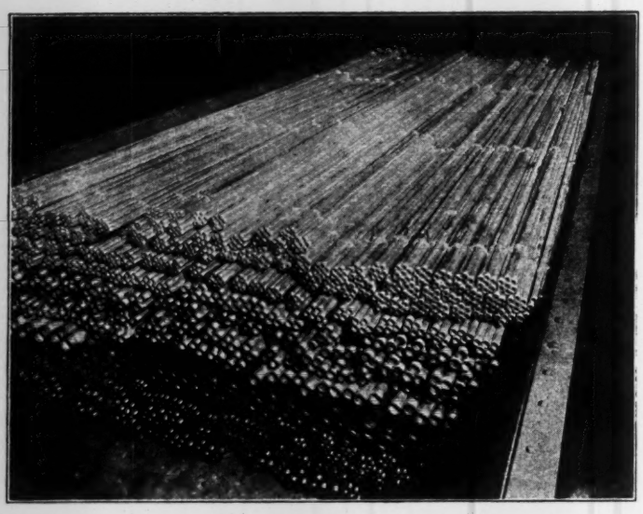
TAKE A TIP FROM THIS BUYER

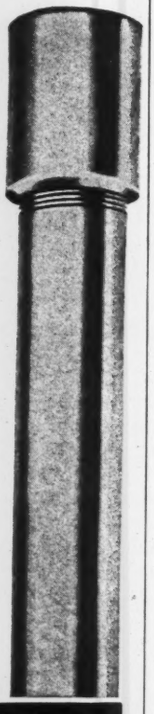


AND ORDER FRETZ-MOON PIPE

HE ordered a carload of pipe in various sizes. He received a carload of pipe in various sizes—and he also received without extra cost in that carload many items not written on the order—items that mean a more profitable installation.

He received pipe that was made from finest quality steel skelp, heated, formed, welded and sized by the scientifically-controlled "continuous process." He received pipe that was absolutely uniform, tightly welded, true to size, perfectly round, straight, accurately threaded and, in the case of galvanized finish, with a non-scaling, rust-resisting zinc alloy surface. He received pipe that had been heated to perfect welding temperature for a definite period of time—not over or under heated—therefore free from hard or burnt spots that would cause trouble in cutting, threading or bending.

Why merely order "steel pipe" when by specifying "Fretz-Moon Steel Pipe" on your order you can obtain pipe with all of the above advantages at no extra cost?



FRETZ-MOON PIPE
BLACK AND GALVANIZED

FRETZ-MOON TUBE CO., Inc., Butler, Pa.

In the winter time we have 160 horsepower connected or used, and the stack temperature is 650 degrees. In the summer time we furnish steam for the kitchen equipment and steam for heating our hot water. In the winter, in addition to the above, the hotel building, which has 177 rooms, requires 11,785 square feet of radiation.

I would like to know when a boiler is run most efficiently, with an over-load or under-load, and is 160 horsepower too much for an 80 horsepower water tube boiler? I might say further that this boiler is mechanically fired with an underfeed stoker.—S. E. B., Managing Director.

Reply: The stack temperature in summer is said to be 225 F and in winter is said to be 650 F. Presumably these temperatures are coincident with the respective peak loads mentioned.

Without more information, one can only generalize. A load of 200 per cent of the boiler rating is a common occurrence with a stoker-equipped water tube boiler, and high efficiencies are practicable under such conditions. In this case, where the bulk of the steam demand is for heating, the 200 per cent output can only occur for a few early morning hours of a comparatively small number of very cold days per season.

The 650 F stack temperature suggests that a reasonable proportion of the heat from the fire is being absorbed, especially as during most of each day the stack temperature undoubtedly is lower than 650 F. Practically all boilers in modern high pressure electric power plants operate constantly at above 200 per cent of the normal boiler rating and are highly efficient. In my judgment more useful heat per pound of coal is obtained when a boiler operates at an overload than when it operates at an underload.

There is a strong probability that the low temperature summer chimney is due to a wasteful excess of air mixed with the products of combustion.

If the stoker and forced draft fan are controlled in parallel so that both stop and start together there is a question whether any further automatic draft regulator would be justified. If the plant is one of the older underfeed type, in which the fan can keep delivering excess air after the stoker has ceased to deliver coal, then assuredly something should be done about it.—Samuel R. Lewis.*

*Consulting Engineer, Chicago, Ill. Member of Board of Consulting and Contributing Editors.

Booklets, Reports and Papers

Standards for Steam Jet Refrigeration

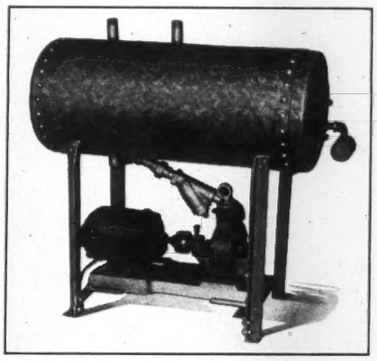
"Capacity and Design Standards for Steam Jet Refrigeration," by C. F. Hendrie, published by Carbondale Machine Corporation in association with Worthington Pump and Machinery Corporation. 10 *page bulletin,* 8x10½.

Standards for the design and capacity of steam jet refrigeration—including vacuum cooling units using barometric jet condensers as well as surface condensers—have been adopted by the vacuum cooling and steam ejector section of the Heat Exchange Institute and are in effect under the auspices of the Institute. Members of the section include American Blower Corp., Carbondale Machine Corp., Carrier Engineering Corp., Croll-Reynolds Engineering Co., Elliott Co., Foster-Wheeler Corp., Ingersoll-Rand Co., Ross Heater and Mfg. Co., Schutte & Koerting Co., Westinghouse Electric & Mfg. Co., C. H. Wheeler Mfg. Co., and Worthington Pump and Machinery Corp.

Capacity ratings have been worked up for twenty standard frame sizes from 15 to 1250 tons refrigeration, chilled water temperatures from 35 to 75 F. Advantages of the standards to the manufacturer are reduced development, lower production cost, prompt shipment—reacting to the eventual benefit of the user—plus the simplification of engineering studies and the preparation of specifications.

This bulletin is a thorough review and explanation of the

Maintains a Constant Water Level in High or Low Pressure Boilers "Automatically."



All Feed Water worries are eliminated when the M-K-O Boiler Feed is used because it: Automatically pumps the feed water against high boiler pressure—Returns the condensate to the boiler—Supplies make-up water as required.
This Unit uses no steam. It can be used with Gas, Oil, Stoker or Hand-fired Boilers.

Ask for literature and prices.

NOTE: We also manufacture the well known Kane Fire-Tube Automatic Gas Steam Boiler and the Ofeldt Water Tube Gas-Fired Steam Boiler. Literature upon request.

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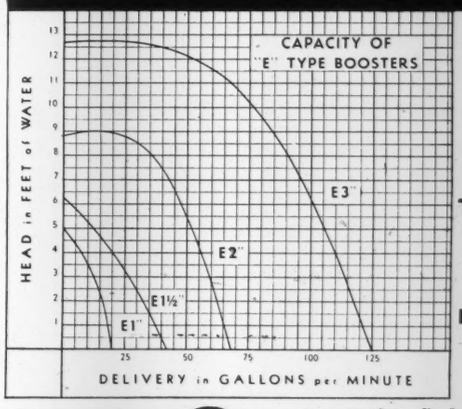

BUY YOUR PUMPS AS THEY SHOULD BE BOUGHT . . . ON A "GALLON PER MINUTE" BASIS

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Compare these B & G Booster capacity curves with those of any other pump designed for the same purpose and you will see why it is no longer good practice to buy pumps by pipe size only. Size for size, the B & G Booster circulates a **greater volume of water** through **a higher Pressure Head** . . . which means that your hot water heating installations can now be designed for smaller pipe sizes and handled with a smaller, more economically operated pump.
B & G Boosters save from 15 to 30% in annual fuel costs when used to improve circulation in hot water Heating Systems. They are sturdily constructed, with two value capacitor, cradled-in-rubber motor—exceedingly quiet in operation. For complete information on the B & G Booster, with typical applications, write for B & G Bulletins B934 and T934.

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WITTENMEIER, a name associated with Refrigeration in all its phases and applications for over 35 years, offers complete Air Conditioning and Refrigerating Systems for industrial processes and bodily comfort, either in Central or Unit Systems from ¼ ton capacity up.

Refrigerants: CO_2—Freon—Ammonia—Methyl Chloride —Steam—Water Vapor.

The Carbonic System, pioneered and developed by Wittenmeier, is classified as the safest of all present day methods. Why sacrifice Safety and Reliability for the extravagant claims and doubtful economies advanced for untried and unproven methods? In the face of these extravagant claims, Wittenmeier, during the season just passed, in the Chicago Area alone, installed fifteen theatre cooling jobs and in each instance, a Carbonic (CO_2) Installation was made. The theatres ranged in size from 400 to 2,000 seats.

Whether you are interested in conditioning a single room, office, shop, restaurant, bank, theatre, auditorium or large office building, there is a Wittenmeier System best suited for the purpose.

Let us make a survey of your requirements and give you our unbiased opinion of the system best suited for your needs. There is no obligation. Wittenmeier, with Air Cooling and Conditioning Experience that dates back to 1908, can offer helpful suggestions. Architects, Engineers, Contractors and others should avail themselves of this service.

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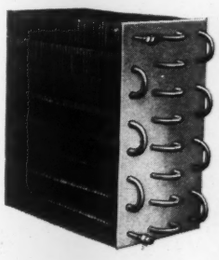

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Individual fin coils can be shipped promptly with any number of tubes high or wide and in lengths up to 12 feet.

This flexibility of construction plus 32 combinations of fin and tube size and fin spacings makes for installation economy and better refrigeration.

ALUMINUM-COPPER-STEEL

THE BUSH MFG. CO.

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SILENT ★★ as the Sphinx

HEATING, PIPING, AND AIR CONDITIONING

The heart of any air conditioning unit is the motor. The life and quality of the motor determine the life and quality of your product.

Holtzer-Cabot motors are used by the leading air conditioning equipment manufacturers because of their outstanding quality.

1 **SILENT OPERATION**—Steel spring mounting definitely and permanently eliminates objectionable motor noise.
2 **BEARINGS**—Oversize bearings and extra large oil reservoirs provide long life with minimum of attention.
3 **ADJUSTABLE SPEEDS**—Provide for the proper regulation of air movement—so vital to the success of the modern air conditioning unit.

Our engineers will gladly confer with you. Their experience can be helpful—write Dept. 20 for descriptive bulletin.

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Simple and Inexpensive

Motor-Unit Centrifugal Pumps—simple as A.B.C., and therefore exceptionally low priced. Pump attached directly to motor, with pump bearings, base and coupling eliminated. No pump lubrication required. Very compact. Suitable for handling anything that flows from clear water to heavy liquids. Fifteen sizes; 5 to over 500 g. p. m. Bulletin 401.

New and Economical

Redi-Return Condensation Units—compact, dependable and inexpensive. Designed to automatically collect and pump back to boiler the returns from heating system, handling water at 210° F. Consists of pump, welded steel tank and float switch. Pressures up to 100 pounds. Bulletin 426.

Write for Bulletins or any other information desired. AMERICAN STEAM PUMP COMPANY, Battle Creek, Michigan.....

AMERICAN-MARSH
Centrifugal and Steam Pumps

standards containing very helpful information on steam jet refrigeration. The author considers the general design and arrangement of steam jet units (both small and large), flexibility provisions, special designs, the materials of construction, methods of control—capacity and economy, standard capacity-temperature characteristic, standard frame size and number of boosters, standard steam pressure ranges, condensers, and steam and condensing water economy.

Copies are available to consulting engineers; heating, ventilating and air conditioning contractors; architects; and others interested in the use of steam jet refrigeration.

A Survey of Air Pollution

"A Survey of the Air Pollution Problem of the City of Scranton (Pa.) and Lackawanna County," conducted by H. B. Meller and Logan B. Sisson of The Mellon Institute of Industrial Research, a series of newspaper articles reprinted from The Scranton "Republican." 44 pp., 6x9, paperbound.

The articles published in this booklet, while reporting an air pollution survey of a particular district, are of general interest as the method of making such a survey is described in some detail, and the causes and results of air pollution (and consequently the remedies) are no different in the locality studied from those in many another town and city.

Following the introduction, the first article deals with the geography of Scranton and environs as it affects the pollution problem, movement of winds, etc. The second article describes the collection and examination of air samples, and the sources of dust. The third considers the expense to merchants and others of dirty air—spoilage of stock, increased decorating and cleaning costs, hygienic effects, and ventilation problems. The next article suggests means of reducing air pollution, including wider use of "smokeless" fuels, and the last installment summarizes the series.

Conventions and Expositions

Heating, Piping and Air Conditioning Contractors National Association: Annual convention, May 20-22, Hotel Gibson, Cincinnati, Ohio. Acting Secretary, S. Lewis Land, 1250 Sixth Ave., New York City.

National District Heating Association: Annual convention, June 11-14, Bellevue-Stratford Hotel, Philadelphia, Pa.

American Society of Mechanical Engineers: Semi-annual meeting, June 19-21, Cincinnati, Ohio. Secretary, C. E. Davies, 29 W. 39th St., New York City.

American Society for Testing Materials: Annual meeting, June 24-28, Book-Cadillac Hotel, Detroit, Mich. Exhibit of testing and related equipment to be held concurrently. 1935 regional meeting to be held in Philadelphia, March 6, and group meetings of committees in Philadelphia, March 4-8. Assistant Secretary, R. E. Hess, 260 S. Broad St., Philadelphia, Pa.

American Gas Association: Annual convention, October 14-18, Atlantic City, N. J.

Book Reviews

Industrial Air Conditioning Practice

"Industrial Air Conditioning Practice," a collection of articles by twenty-five engineers. Published by the Keeney Publishing Company, 6 N. Michigan Ave., Chicago, Ill. 324+ viii pp., 5½x8½, clothbound. $2.50.

Despite the widespread applications of industrial air conditioning, little information of a practical nature has been available in book form. This book therefore aims to give a picture of how

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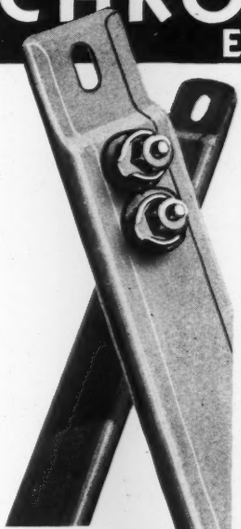

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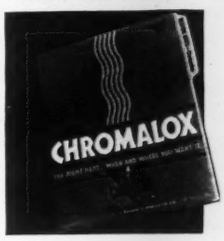

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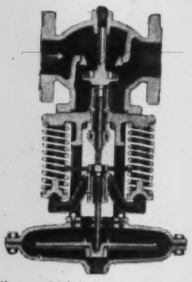

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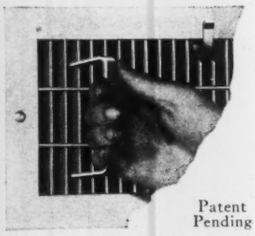

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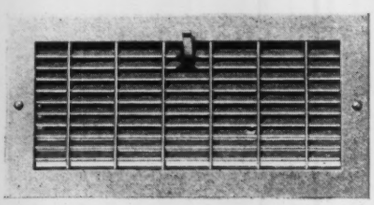

air conditioning is applied in a number of plants in several different industries, explains the problems encountered and how they have been solved, and suggests what air conditioning can do in aiding efficient, economical manufacture of a better product.

As industrial air conditioning requires not only a knowledge of the subject of air conditioning itself but a more or less intimate acquaintanceship with the particular industrial process, air conditioning engineers have tended somewhat to specialize in an industry or related group of industries. This book's value can therefore be measured to some extent by the fact that the material (originally published in HEATING, PIPING AND AIR CONDITIONING) has been contributed by twenty-five such engineers. As a result it is comprehensive enough to cover the air conditioning problems common to all industries as well as the specific problems encountered in many particular processes.

Because air conditioning may, not incorrectly, be thought of as the treatment of air to meet the particular requirements of a process or product it may mean humidification in one industry (textiles, for instance), cooling and dehumidification in another (bakeries), etc. This book is consequently divided into a number of sections, each section containing chapters related in that the air conditioning requirements are similar. These sections are: Fundamentals; Humidification; Humidification and Dehumidification; Cooling and Dehumidification; Dehumidification and Drying; Dust Control; Air Conditioning Auxiliary Industrial Buildings; and Maintenance and Operation. These eight sections are sub-divided into a total of twenty-three chapters, each pertaining to a specific phase of the subject.

Water Supply in Buildings

"Water Supply in Buildings," by Alexander W. Moseley, published by Mumm Print Shop, Evanston, Illinois. 92 pp., 6x9, paperbound. $1.15.

Concerned primarily with the physical distribution of water for ordinary purposes, this booklet is intended to be a convenient compilation of information on the methods employed in and the data required for working out the piping layouts for water supply in buildings. It is divided into thirteen sections and fifty-eight articles for easy reference.

Particular attention is devoted to the method of probability as applied to the determination of proper pipe sizes.

Handbook for Gas Engineers

"Gas Engineers' Handbook," prepared by a committee of the Pacific Coast Gas Association and reviewed by a committee of the American Gas Association, whose directors endorse it. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1018 pp., 6x9, clothbound. $7.50.

This most comprehensive manual brings together in one volume the physical, chemical, thermodynamic and other constants, formulas, and data used in the manufacture, distribution, and utilization of gas. So completely and extensively are fundamentals covered that many engineers other than those concerned directly with gas will find it a valuable reference; in fact, the first three sections, comprising nearly 150 pages, are devoted to mathematical tables and graphs; properties of elements, common substances, and engineering materials; and properties of gases, air, steam, and water—all of general interest. Section IV deals with fuels (solid, liquid, and gaseous), their combustion, and heat transfer.

Section V, consisting of some 360 pages, takes up the production of gas, going into the subject in detail. In Section VI, testing and measurement are considered; Section VII is devoted to transmission and distribution, pipe-line welding and pipe corrosion being among the subjects included.

In Section VIII, utilization is covered, both industrial and domestic. Headings in this section include pipe layouts, flues and chimneys, appliances, domestic heating and air conditioning, flow through orifices, burner design, and industrial applications, the latter being particularly informative.

Radiator Reference Book

"The Pape-Swift Radiator Reference Book," published by John S. Swift Co., Inc., 105 S. Ninth St., St. Louis, Mo. 312 pp., 5¼x8¼, planographed, paper-bound. $1.00, plus 10c for postage.

This radiator reference book contains the ratings and dimensions of obsolete, modern, and concealed radiators, nineteen different manufacturers being represented. The information is reproduced directly from the published data of each manufacturer by the planograph process, is logically arranged, and conveniently indexed. Principal advantage of the book is in making available in one place the ratings of different makes of radiators.

This radiator book is a companion to the boiler reference books published by this company.

Boiler Reference Book

"The Pape-Swift Boiler Reference Book (1935)," published by John S. Swift Co., Inc., 105 S. Ninth St., St. Louis, Mo. 440 pp., 5¼x8¼, planographed, paper-bound. $1.00 plus 10c for postage.

Not a new edition of the 1934 boiler reference book, but a supplement to it is the 1935 book. It includes the specifications of many manufacturers not included in the earlier book, data on more obsolete boilers than were previously included, and information on boilers which have been added to various manufacturers lines in recent months.

The products of over thirty manufacturers are represented, and such information as boiler numbers, grate area, heating surface, and manufacturer's rating is given; the pages are reproduced direct from the individual manufacturer's data by the planograph process.

This book is a companion to the radiator reference book issued by the same company.

Four Testing Society Publications

"A. S. T. M. Tentative Standards," 1250 pp., 6x9, clothbound, $8.00; paperbound, $7.00.

"Index to A.S.T.M. Standards and Tentative Standards," 142 pp., 6x9, paperbound. Available on request from the publisher.

"Specifications and Tests for Coal and Coke," 108 pp., 6x9, paperbound. $1.00.

"Symposium on the Outdoor Weathering of Metals and Metallic Coatings," 114 pp., 6x9, paperbound, $1.25; clothbound, $1.50.

All of the above are published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.

The book of *A. S. T. M.* tentative standards (issued each year) is the only volume containing all of the Society's tentative specifications, methods of test, and definitions of terms covering engineering materials and the allied testing field. The present 1934 edition contains 236 tentative standards, 48 of which are included for the first time and some 60 of which have been revised and are included in their latest approved form. Among the new ones are tentative standards for electric fusion welded steel pipe for high temperature and high pressure service; alloy steel casting for valves, flanges and fittings for service at temperatures from 750 to 1100 F; seamless alloy steel pipe for the same range; fuel oils; and many others. A complete subject index is included, and two tables of contents are given.

The index to *A. S. T. M.* standards and tentative standards (dated January 1, 1935) is a convenient reference for engineers, architects, purchasing agents, and others in determining if specifications or test methods for any particular materials or subjects are available, and where they may be found. The total number of *A. S. T. M.* standards and tentative standards is approximately 750.

The coal and coke specifications booklet is a compilation of all the standard and tentative specifications and tests for coal and coke issued by the *A. S. T. M.* It includes 5 specifications, 13 test methods, and standard definitions of terms.

The papers and discussions in the outdoor weathering booklet

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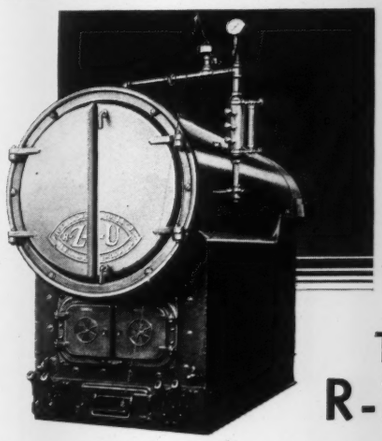

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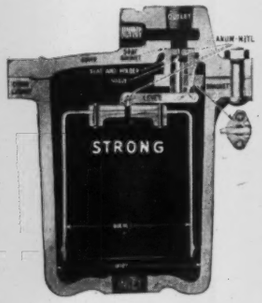

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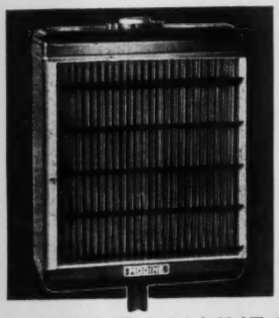

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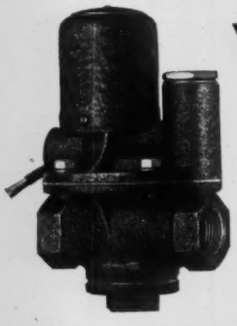

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were presented as a part of the symposium on this subject at the regional meeting of the Society in Washington last March, and deal primarily with an analysis of performance data obtained from tests carried on by two of the Society committees. They are intended to illustrate uses to which the data may be put by engineers, and discuss many of the topics involved in this subject.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on next page

No. 253. AIR CONDITIONERS: Unified Air Conditioner Company, Duluth, Minn. 16 page catalog on air conditioning, describing the five models of air conditioners manufactured by this company, showing installation details, and tabulations of capacities and dimensions. A special section on controls concludes the booklet.

No. 254. AIR CONDITIONING: Kelvinator Corporation, 14250 Plymouth Rd., Detroit, Mich. 20 page booklet discussing "exact selection" of air conditioning systems (unit and central types) for hotels and restaurants, stores and shops, homes and apartments, recreation and amusement places, professional offices, general and executive offices, industrial processing, hospitals, and churches and funeral homes. Each section is illustrated with a diagram of an installation. The importance of suiting the system to the particular application is stressed.

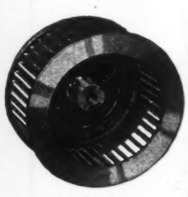
No. 255. CONTROLS: Automatic Products Company, 121 N. Broadway, Milwaukee, Wis. Loose-leaf condensed catalog of standard automatic controls for heating, ventilating, air conditioning, and refrigeration giving complete descriptions, illustrations, list prices, etc. Humidity regulators, thermostats, and valves for refrigerant, water, oil, and gas control are included.

No. 256. CONTROLS: Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia, Pa. Folder briefly describing this company's line of relays, timing devices, electric counters, thermostats and electric pots and ladles, with notes on their applications.

No. 257. DRIVES: Worthington Pump and Machinery Corporation, Harrison, N. J. 4 page folder "Grip Saves Power," on V-belt drives.

No. 258. HOT WATER HEATING: Bell & Gossett Co., 3000 Wallace St., Chicago, Ill. Loose-leaf catalog describing operation of water heating systems illustrated with installation diagrams, piping layouts, capacity charts, etc.—a reference manual on heating domestic water and hot water circulation control. Among the products covered are triple duty water heating systems, booster pumps, boiler water flow control devices, indirect heaters, and draft control.

No. 259. INSULATION: The Ruberoid Co., 500 Fifth Ave., New York, N. Y. Series of folders on insulation, pipe covering,



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and insulating cements of various types, describing and illustrating each type and its particular applications.

No. 260. MECHANICAL RUBBER GOODS: The B. F. Goodrich Company, Mechanical Division, Akron, Ohio. 24 page bulletin of engineering data on industrial rubber goods, describing over 200 items and including tables and technical data of general interest. Belting, hose, fittings, packing, hard-rubber pipe and fittings, rubber lined pipe, fittings, and valves, are among the products described.

No. 261. MOTOR BRUSHES: The Ohio Carbon Co., 12508 Berea Rd., Lakewood, Ohio. 64 page pocket-size booklet dealing in practical, non-mathematical terms with the causes and effects of sparking, excessive wear, etc., of brushes, commutators, and slip rings on direct and alternating current motors and generators; the booklet is titled "The Brush Phase of Motor Maintenance," contains ten sections of general as well as particular information on the subject.

No. 262. PUMPS: Goulds Pumps, Inc., Seneca Falls, N. Y. 128 page 1935 dealer catalog of pumps and water systems, including a number of new and improved products and a special section of engineering data. Sections on shallow and deep well pumps and systems, accessories, hand pumps, power pumps, and engineering pumps are included.

No. 263. SPRAY EQUIPMENT: Binks Manufacturing Co., 3106 Carroll Ave., Chicago, Ill. 32 page booklet describing, illustrating and giving prices for spray painting equipment including spray guns, regulators, nozzles, compressors, portable outfits, spray booths, exhaust units and other equipment.

No. 264. WATER COLUMNS AND GAGES: Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. 4 page catalog supplement describing "eye line" indicator to enable reading of boiler water levels at the boiler room floor, useful for high boilers. Typical assemblies are diagrammed.

No. 265. WELDING ROD: Air Reduction Sales Company, 60 E. 42nd St., New York, N. Y. 8 page leaflet on three types of shielded arc electrodes, having tensile strengths from 65,000 to 75,000 lb per sq in., 22-30 per cent elongation, higher resistance to corrosion than mild steel. One type is recommended for flat welding, the second for vertical and overhead work and the third—with similar characteristics—has an elongation about five per cent greater.

No. 266. WELDING MACHINES: Air Reduction Sales Company, 60 E. 42nd St., New York, N. Y. 8 page bulletin describing in detail "Airco-Wilson" arc welding machines of several types, and giving a table of ratings and capacities.

No. 267. WELDING MACHINES: The Lincoln Electric Company, Cleveland, Ohio. Data sheet for a-c motor-driven types "SAC300" and "SAC500" arc welders, including description, construction, and ratings.

No. 268. X-RAY INSPECTION: St. John X-Ray Service, Inc., 30-20 Thomson Ave., Long Island City, N. Y. 4 page circular recording ten years pioneering service in x-ray inspection.

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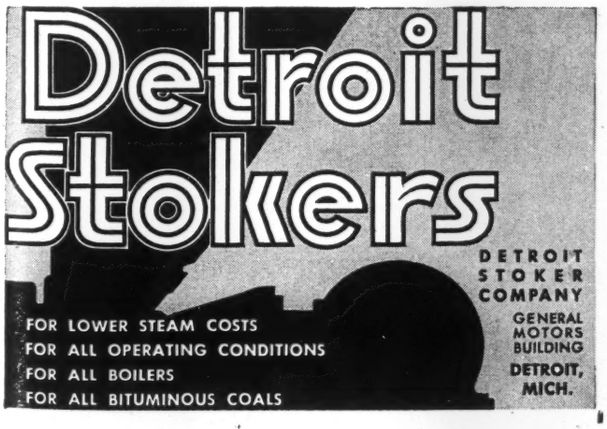

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